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CIVIL ENGINEERING

Published by the American Society of Civil Engineers

CHANNEL IMPROVEMENT A VALUABLE AID TO FLOOD CONTROL ON THE MERRIMACK RIVER
View of Rock Excavation, Looking Upstream from Moody Street Bridge at Lowell, Mass.

Volume 7 — *Number 11*

NOVEMBER 1937

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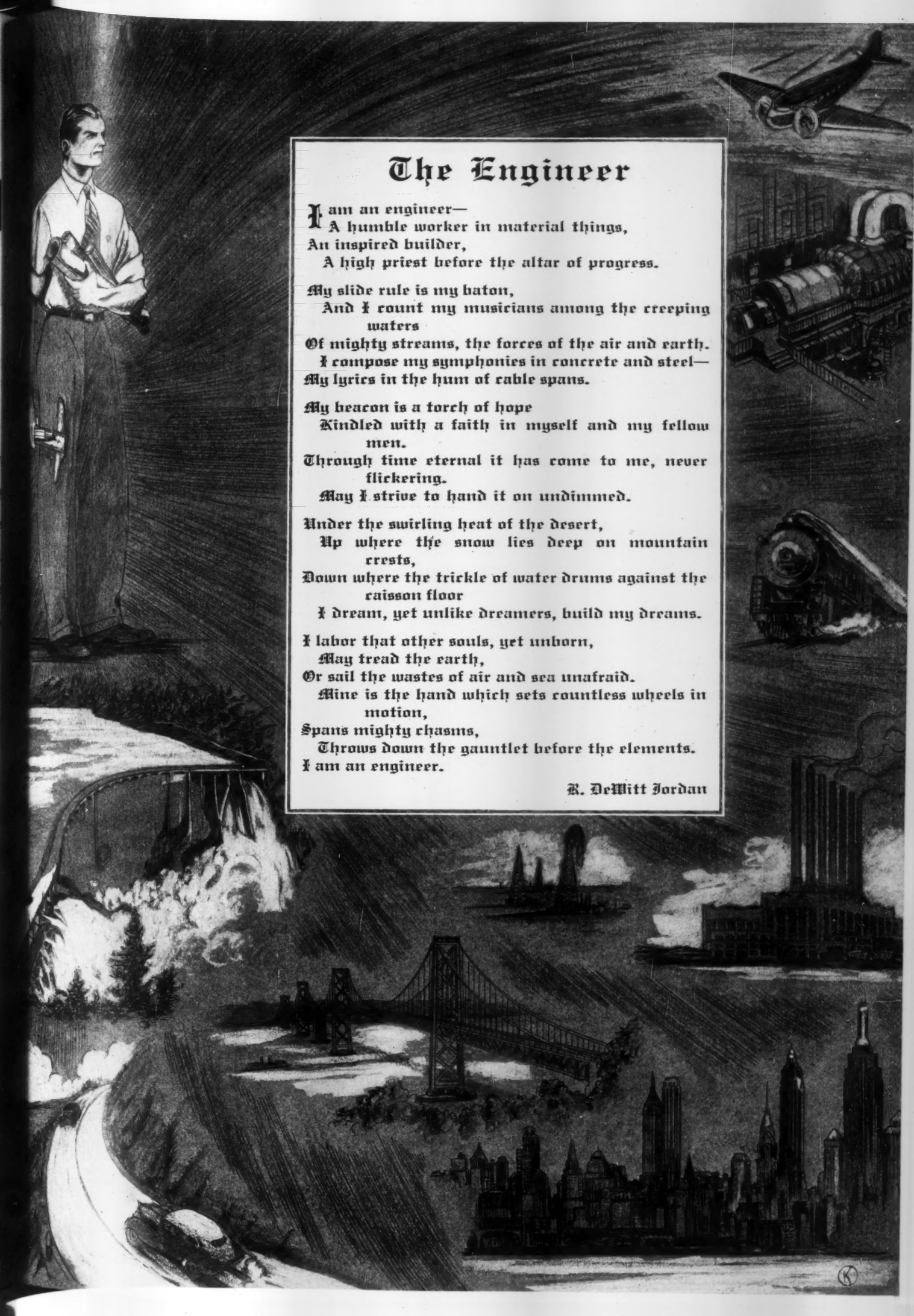

The Engineer

I am an engineer—
A humble worker in material things,
An inspired builder,
A high priest before the altar of progress.

My slide rule is my baton,
And I count my musicians among the creeping waters
Of mighty streams, the forces of the air and earth.
I compose my symphonies in concrete and steel—
My lyrics in the hum of cable spans.

My beacon is a torch of hope
Kindled with a faith in myself and my fellow men.
Through time eternal it has come to me, never flickering.
May I strive to hand it on undimmed.

Under the swirling heat of the desert,
Up where the snow lies deep on mountain crests,
Down where the trickle of water drums against the caisson floor
I dream, yet unlike dreamers, build my dreams.

I labor that other souls, yet unborn,
May tread the earth,
Or sail the wastes of air and sea unafraid.
Mine is the hand which sets countless wheels in motion,
Spans mighty chasms,
Throws down the gauntlet before the elements.
I am an engineer.

R. DeWitt Jordan

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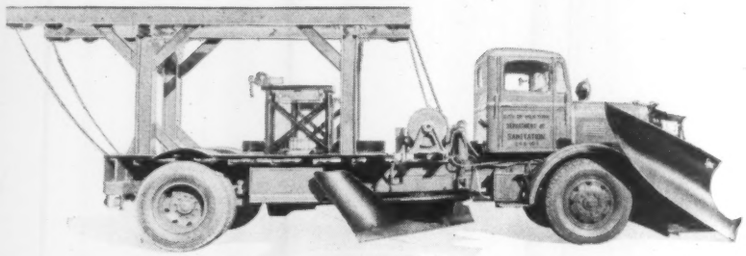

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VOLUME 7 NUMBER 11

November 1937

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

Entered as second class matter September 23, 1930, at the Post Office at Easton, Pa., under the Act of August 24, 1912, and accepted for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 5, 1918.

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Printed in the U. S. A.

CIVIL ENGINEERING

Published Monthly by the

AMERICAN SOCIETY OF CIVIL ENGINEERS
(Founded November 5, 1852)

PUBLICATION OFFICE: 20TH AND NORTHAMPTON STREETS, EASTON, PA.

EDITORIAL AND ADVERTISING DEPARTMENTS:
33 WEST 39TH STREET, NEW YORK

This Issue Contains

THE ENGINEER—*Adapted from a Page in the February 1935 "Wisconsin Engineer"*—Page of Special Interest 5

SOMETHING TO THINK ABOUT
What Should the Technical School Teach? 735
Scott B. Lilly

SOME ENGINEERING BEGINNINGS 735
Richard Shelton Kirby

FLOOD CONTROL IN NEW ENGLAND
Water Resources Committee Recommendations for New England 740
H. K. Barrows

Army Engineers' Plan for Connecticut Valley 744
Mason J. Young

Army Engineers' Plan for Merrimack Valley and Principal Maine Rivers 750
Hugh J. Casey

THE MANUFACTURE OF STRUCTURAL CLAY PRODUCTS 755
F. E. Emery

GEOLOGY AND CIVIL ENGINEERING 760
William Otis Hotchkiss

SOCIAL HORIZONS OF THE ENGINEER 763
Harry J. Engel

ENGINEERS' NOTEBOOK

Analysis of Stress in Pedestals 767
Frank Schaffel

Use of Reinforced Brickwork in Lincoln Tunnel Buildings . . 769
C. W. Dunham

Short-Cuts in Preliminary Highway Surveys 770
Wallace W. Sanders

Forecasting Rainfall by Mean Seasonal Distribution 771
Henry Wenderoth

OUR READERS SAY 772
SOCIETY AFFAIRS 775
STUDENT CHAPTER NOTES—Annual Reports for 1936–1937 . . . 795
ITEMS OF INTEREST 807
NEWS OF ENGINEERS 811
DECEASED 812
CHANGES IN MEMBERSHIP GRADES 813
APPLICATIONS FOR ADMISSION AND TRANSFER 815
MEN AVAILABLE 10
RECENT BOOKS 12
CURRENT PERIODICAL LITERATURE 14, 16, 18
EQUIPMENT, MATERIALS, AND METHODS 22, 24
INDEX TO ADVERTISERS, INDUSTRIAL AND ALPHABETICAL 26, 28, 30, 32, 34, 36

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SUBSCRIPTION RATES

Price, 50 cents a copy; $5.00 a year in advance; $4.00 a year to members and to libraries; and $2.50 a year to members of Student Chapters. Canadian postage 75 cents and foreign postage $1.50 additional.

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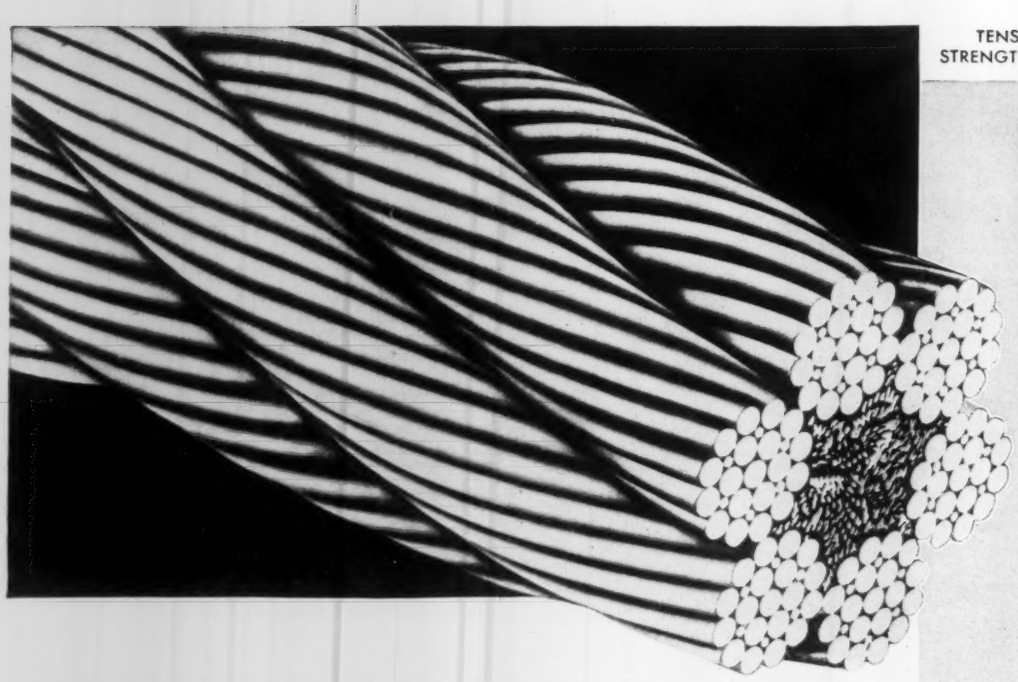

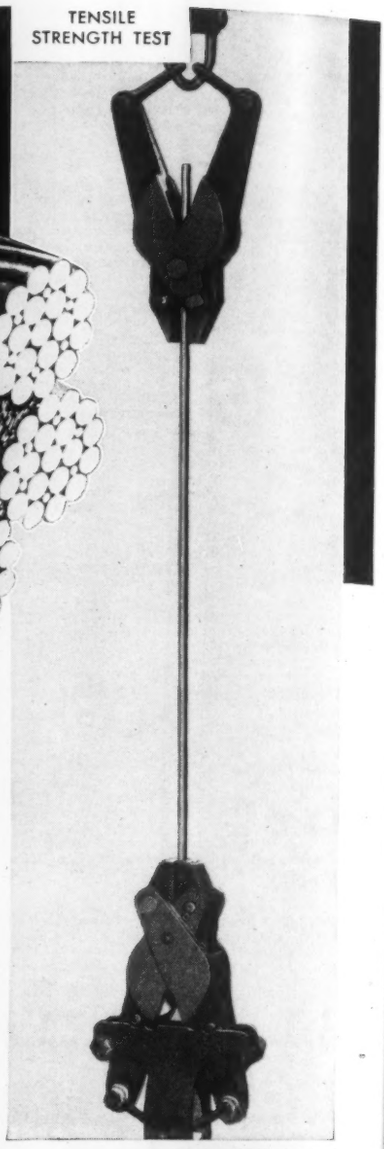

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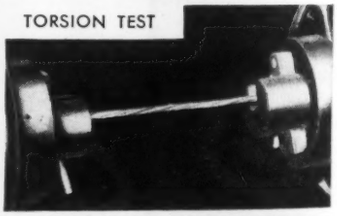

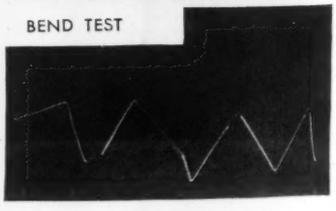

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

What Should the Technical School Teach?

By Scott B. Lilly

Member American Society of Civil Engineers
Professor of Civil Engineering, Swarthmore College, Swarthmore, Pa.

ONE of the best informed civil engineers with whom I am acquainted told me only a short time ago that he found it well nigh impossible to keep up with the new developments in his particular field. In fact, he said, much of the material is written in such a way that he cannot read it. As I listened, knowing from my own experience how true his statements were, I thought again of the problem of training young engineers when new developments are following one another so fast that even this engineer, devoting more than the average amount of time to study, cannot keep abreast of them. This question, then, demands attention: What is the most effective way to use the four years that are now devoted to undergraduate training?

Perhaps some historical background will illumine the picture. Technical schools, as a significant development in the United States, came into existence following the Civil War. At that time, industry was clamoring for men trained for certain specific jobs. Men who graduated in civil engineering as late as 1903 have told me that long before the end of their fourth year, every senior had a place on a field party of some railroad. Many of these men, with only enough training to run a curve, located railroads. They may have been inefficient, but the financiers responsible for building the roads were interested in one thing only—to get the trains running. Any man who could help them do that was valuable. This was the period when course after course was added to the curriculum to meet certain specific needs. However, as time went on, there grew up in industry a technical group large enough to train its own cadets. At present, we find many of the largest industrial concerns maintaining courses for college graduates lasting from one to two years, in which they give additional training for their own needs. Such companies are not interested in highly specialized college courses.

Industry Enters the Field of Research.~Business competition today is keener than ever; but it is competition of a different kind. When the railroads were being built, the danger was that the engineers might fail to find the best location, so that a rival road built with lower grades and better alinement could reap a profit at the expense of the original road. Today the competition is between industries—oil versus coal, railways versus trucks, rayon versus cotton, steel versus concrete. The great fear of the present executive is obsolescence—that some new process will be developed which will make his whole plant valueless. To meet this condition we find the progressive companies entering the field of research. The larger companies have their own laboratories, while the smaller ones are combining to form trade associations, hiring the best men they can find, and spending lavishly to discover new methods that will bring them added business.

This research has produced better materials, better manufacturing methods, and better designs. But how has it affected the requirements for a four-year undergraduate course? Does it call for a broader training?

The theory underlying a broad undergraduate training is that instead of trying to keep up with all the changes that are taking place in each field, a college should reduce the number of courses taught, do away with special curricula, and concentrate on the things it can do best. The time is still far distant when engineering will be all science. Many of the structures being built even today are standing not because the theory of design is absolutely correct, but because the computations result in a structure similar to one that has proved satisfactory. In some cases it may be years before theory catches up with practice. Nevertheless, I think that the colleges should teach the science of engineering—that is, that students should spend the major part of their four years on the underlying principles of engineering, devoting only a moderate amount of time to applications.

Principles, Not Rules, Should Be Stressed.~Teaching in the past has been concerned with the formal processes involved. Men have learned how to do things, rather than why. They learned rules. But would it not be better to teach all courses from the standpoint of developing principles? For years the student has asked why he must spend so much time on mathematics when practicing engineers have told him that they rarely, if ever, have occasion to use the calculus. He does not realize that he will use the type of reasoning he learned in the calculus, although unconscious of where he learned it. Mathematics, then, must be taught so that the principles remain even though the formal processes, the rules, are forgotten.

Again, let us consider two courses in structures. In one, the class designs a bridge, using one of our formal and widely adopted sets of specifications. They go through the entire design, and when any question arises as to whether one method or another shall be adopted, the answer is found in the specifications. In the other course, the student actually continues his study of structural theory. When a question arises, it is answered not by consulting a specification but by referring back to the mechanics involved; the exact causes are studied and the answer will conform to the theory developed and not to the specification. When these two classes leave college only a comparatively small percentage of their members will actually design the type of structure covered by the specification used. The rest will do what designing their practice requires, not from a set of rules but from the basic theory. If the man from the theoretical group finds himself in a job where the exact specification is used, in a matter of three or four weeks he can make himself as familiar with it as his associates; on the other hand, when the inevitable exception is encountered, he will have something to draw on that they lack.

What Should the Curriculum Include?—In a "broad" curriculum, the first three years would be identical for civil, mechanical, and electrical engineers. The courses would include mathematics, physics and chemistry, descriptive geometry, kinematics, mechanics (both analytic mechanics and strength of materials), electrodynamics, hydraulics, and thermodynamics. This work would occupy three-quarters of the student's time for the first three years. In the senior year, he would be allowed to specialize in that branch of engineering in which he is most interested. He would have had the basic courses in all three fields and could take any advanced course offered. The word "specialize" has been used to describe the work of the last year, but it is somewhat of a misnomer, for the work would be advanced theory along the line chosen by the student, with just enough of its application so that he can see how the theory of the first three years does apply. The attempt should be made in at least one of these selected courses to carry the man as far as he is able to go—to acquaint him with the frontiers of knowledge in that field, so that he can see that engineering is not a dead thing, but a living, growing profession that will demand his best efforts.

The Unity of Engineering Education.—In the Wickenden report, sponsored by the Society for the Promotion of Engineering Education, considerable space is devoted to showing the unity of engineering education. Everything that is taught is based on the natural sciences, and each succeeding course is built upon the one that has gone before. As the work approaches the graduate field, it becomes clear that the different branches of engineering overlap. The same mathematics applies equally well in advanced aeronautics, soil mechanics, impact studies for railroad bridges, transients, and the design of steam turbines. Because these fields come so close to each other, the graduate student is aided greatly in getting a clear understanding if he has previously mastered the basic theory.

It will be noted that the type of course I am advocating is not an "appreciation course"—something that will merely make the student familiar with the names of the subjects—but rather something that will give him a real introduction to the theory involved. The thing to be accomplished is to give the student the mental grasp that will enable him to undertake the investigations required in all the research work now being undertaken. If he can think for himself, is willing to accept responsibility, and is confident that he knows what he is supposed to know, he will have no difficulty in finding a place for himself.

Study of Social Science Is Essential.—So far in this discussion we have emphasized the technical side of engineering education. While it is essential that the colleges should fit a man to hold some job upon graduation, while it is true that if he is to climb in his profession he must first be able to get a toehold where he can show that he is master of something, can earn more than he is paid, and can prove that he is capable of carrying greater responsibility, it is increasingly important that he should have a grasp of human affairs. President Aydelotte of Swarthmore College says in the introduction to his book, *English and Engineering:*

"The engineer is destined to become an important figure, a leader, in the new age which is just now dawning. He cannot occupy a position of such importance without his heavy share of duties and responsibilities. He cannot be a leader without taking upon himself the task of solving many of the gravest problems of our civilization, human problems as well as mechanical, problems in finance, in government, in education, and in social life. The engineer must direct the labors of thousands of uneducated men, and he cannot escape some responsibility for their well-being. The work of his hands and brain may build up or destroy the welfare of whole industrial communities and of gigantic corporations. As an employer of younger engineers he must take an active part in their education, that great part of education which comes when school days are over, and he may, if he have the wisdom, exercise a human influence more important than he can ever estimate. With such a rôle to play . . . , the engineer must think in terms of civilization, in human terms as well as material, or be a traitor to his opportunities."

The broad engineering education, then, must include courses that cover the human side as well as the material side of the profession. But a "course" in college is not an end; if it fails to develop a keen desire to know more, to go into the subject more deeply, it may be worse than useless. Comparatively few courses can be added to the crowded engineering curriculum; therefore individual members of the engineering faculty must be urged to teach each subject so that its social significance will be recognized. But the greater part of this kind of education must come after graduation—and this will be true no matter how many courses were taken in college. The most important thing, therefore, is to instill the desire to be well read and well informed, not as a window dressing, but as equipment to face social problems and do something about them.

Conclusion.—The engineer of the future must be a specialist, but he must not be a specialist of the narrow kind. He must be well grounded in the natural sciences, well read, and well informed. I believe that the type of course outlined is the best foundation on which to base the advanced education of the specialist, and that it furnishes, as well, the best equipment for life for those who will not require a highly specialized professional training.

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CIVIL ENGINEERING

NOVEMBER 1937

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VOLUME 7

NUMBER 11

Some Engineering Beginnings

Salient Developments in Engineering up to the Middle of the Eighteenth Century

By RICHARD SHELTON KIRBY
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CHAIRMAN, DEPARTMENT OF ENGINEERING DRAWING, SCHOOL OF ENGINEERING, YALE UNIVERSITY, NEW HAVEN, CONN.

ALTHOUGH there is basis for the recent claim that engineering did not take a place among the learned professions much before the middle of the eighteenth century, its beginnings go back at least as far as 3000 B.C. Starting in Egypt and Mesopotamia, the center of construction activity later shifted to Rome and its provinces. But by the beginning of the Christian era, China's Great Wall, Grand Canal, and certain irrigation systems had already taken form. Construction of bridges and roads continued in China, and in the New World came to a climax with the Incas about 1300, while western Europe was still in the Dark Ages. Unfortunately, however, few records of these early Asiatic and American achievements exist, and the engineering historian is forced to chronicle European developments mainly. In the accompanying article Professor Kirby sketches high lights in the story of engineering up to about the year 1750.

ENGINEERING is an old profession. Like the other professions, it was undoubtedly practiced in what we naïvely term prehistoric days. If it should be asked where and when engineering began, the best answer would probably be that this took place wherever and as early as men attempted buildings of any permanence, and that the first engineer was an individual with a fondness for bending natural forces to his will and a genius for planning operations. In fact civil engineers and architects were indistinguishable until about a century and a half ago.

What has been considered by some to be the earliest engineering work extant dates from about 3000 B.C. This is a section of the wall of a royal Egyptian tomb, a stone chamber inside a mud-brick pyramid. However, recent explorations in the Euphrates and Tigris valleys have uncovered stone walls which may well antedate this. It should be noted that the construction of the pyramids of Egypt and the hardly less imposing pyramids of Central America and Mexico presented complex engineering problems—there were not only the tombs themselves to build, but also temporary construction; ramps, perhaps spiral in form; also viaducts, docks, and temporary and permanent roads. Some authorities believe that Egyptian engineers built crushed-stone roads not unlike the modern type, but no one really knows.

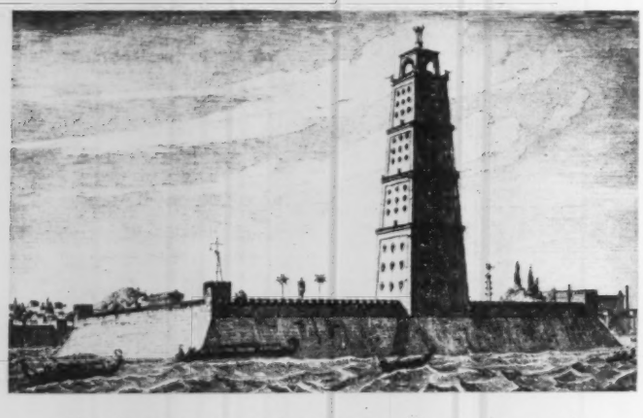
Many a statue may still be seen representing Imhotep, an Egyptian official of about 3000 B.C., who was superintendent of public works under Zoser. He was plainly a civil engineer. Furthermore, he excelled all men of his time in medicine, magic, and in the formulation of proverbs, and was altogether the first citizen of the Old Kingdom.

Something like a thousand years before Moses, one Gudea of Lagash, an engineer (or architect) of ancient Babylonia, was commemorated in stone, with a scaled plan on his lap and his pen and ruler beside it. Nine or ten statues of him, mostly minus heads, are in the Louvre, and there are others elsewhere. We should properly term Gudea a king or *patesi* with a penchant for engineering.

Much engineering work was of necessity carried out in and around old Babylon. Herodotus has it that the 600-ft width of the Euphrates was spanned by a wooden bridge on stone piers, designed for the nervous Queen Nitocris, who insisted that the superstructure, or perhaps a single span only, come down every evening and be restored at daybreak! Some authorities associate the building of such a bridge with Queen Semiramis, of hanging garden fame, and the supposition is not at all improbable. And there are even stories, doubtless legendary, of a tunnel under the Euphrates at Babylon. While the ancients of pre-Roman days seem to have built almost no bridges of any permanence, their army engineers were skillful in constructing pontoon bridges. Some of them had to be, or suffer the tragic fate said to have been meted out to the engineers of Xerxes' army after a gale had defeated their attempt to bridge the mile-wide Hellespont.

SOME ANCIENT HYDRAULIC WORKS

Thousands of years ago, many ancient cities in western Asia had fairly elaborate drainage, irrigation, and water-supply systems. Reservoirs and conduits are still being unearthed in Uruk and elsewhere. Solomon and Hezekiah each constructed parts of an underground system for Jerusalem; the latter was responsible for the boring of an aqueduct tunnel a third of a mile long, curved like the letter "S." Herodotus, five centuries before Christ, wrote proudly of such a tunnel that was nearly straight and some four thousand feet long, on the little island of Samos, off the coast of Asia Minor, not far from his birthplace. The engineer and builder, Eupalinus of Megara, otherwise almost unknown to fame, deserves high praise for his courage in driving such a tunnel through a mountain a thousand feet high, working from both sides toward the middle, with nothing but hammers



THE LIGHTHOUSE OF ALEXANDRIA (RECONSTRUCTED)
This First-Order Light, Built by Sostratus of Cnidos in 284 B.C., Was Overthrown by an Earthquake in 1303. From Friedrich Adler's *Der Pharos von Alexandria*, Berlin, 1901

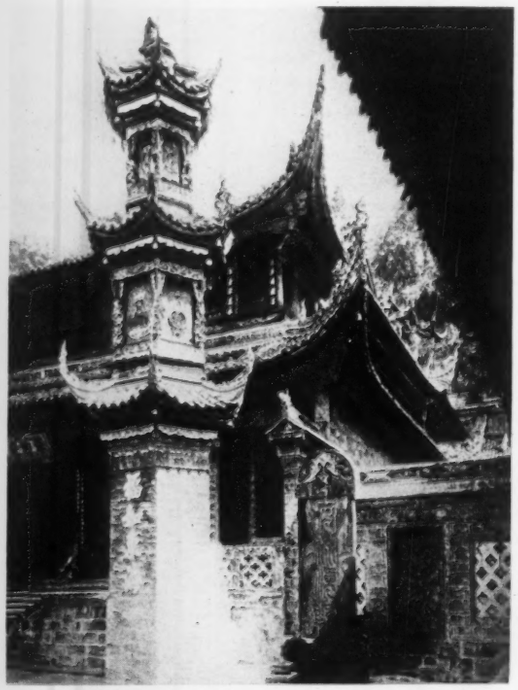
and chisels and fire and water, and perhaps (but probably not) vinegar. The elder Pliny remarks in his *Natural History* that the latter is useful for breaking rock. Eupalinus had more than courage, for the two halves of his Samos tunnel actually met within a little matter of 15 or 20 ft!

As early as the days of Herodotus, there apparently was a ship canal close to a hundred miles long connecting the lower Nile with the Gulf of Suez. It seems to have been begun by one of the earlier Egyptian kings and taken up later by Necho, who, living about 600 B.C., before bacteria, the eight-hour day, or workmen's compensation had become officially recognized, buried some 120,000 of his faithful subjects along the line of the project before he gave it up in despair. Some accounts used to have it that Necho started the canal at the Nile, but actually never made the Red Sea connection, because some one (let us insist it was not his engineer) assured him that if he did the sea would rush back through such a channel and flood all Egypt! Darius the Persian finally finished the canal, and it was used for centuries, but only a few vestiges remain.

The various nations trading up and down the Mediterranean in pre-Roman days had a number of well-developed harbors. Among these was Alexandria with its lighthouse almost as tall as the Washington Monument. This first-order light served mariners from 284 B.C., just after the death of Alexander the Great, to 1303, when it was finally overthrown by an earthquake. The engineer-architect for the great structure was Sostratus of Cnidos, who surreptitiously carved his name on the base, underneath some softer stone which afterward disappeared.

In the third century before Christ, in western China, an elaborate irrigation system was so successfully executed by two engineers, Li Ping and his son Örl Lang, that the grateful rice-farmers of the once arid plain built the Temple of the Tamed Dragon in their honor, and still pay them homage as demigods. We are still behind the Chinese in this respect, since our Hall of Fame includes only one engineer among its 69 celebrities. The Grand Canal in eastern China, half again as long as our Erie Canal, was begun more than two thousand years ago, and perhaps from the first contained devices comparable to locks. The Great Wall of China, the most gigantic engineering work of all time, was first built in the last two or three centuries before the Christian era, and levees have been common sights along the principal Chinese rivers for at least as long a time.

One of the greatest of the early engineers was the Greek (or Egyptian) Heron, professor, as we should say, of mathematics, physics, mechanics, and engineering at the University of Alexandria. Strangely enough his exact century is problematical, and whether the professor lived a century or two before the Christian era or a century after its beginning is not positively known. He is best known to modern readers for his researches in what we call thermodynamics. But he wrote one of the earliest treatises on surveying, formerly called "rope-stretching," and he had a positive genius for turning abstract Euclid to practical account.



CHINESE TEMPLE OF THE TAMED DRAGON
Built to Honor the Engineers Li Ping and Örl Lang, Who Constructed an Elaborate Irrigation System in Western China in the Third Century Before the Christian Era

THE ROMANS EXCEL IN CONSTRUCTION WORK

We come now to the Romans, who, with their talent for organization, accomplished much engineering work of a high order. Only a small proportion of their engineers and architects were from the Italian peninsula. Their laborers were largely prisoners of war or perhaps convicts. In the colonies and outlying districts the Roman legions were employed in times of peace on much construction work of a civil nature, partly to keep them out of mischief. There were also contractors in Roman days, for Cicero remarked, in his Sixth Paradox, that material wealth could be acquired honorably in three ways, one of which was contracting for public works.

Before the days of the Romans there were few roads worthy of the name anywhere. Roman road building, however, served to bind together far-flung provinces for administrative, economic, and military ends, and some 50,000 miles of these roads are still more or less in use. Their most costly road was the Via Appia, finished in 244 B.C. and named for the censor Appius Claudius, who began it. This is practically a city pavement, extending some hundreds of miles southeast from the capital, a massive structure built for all time. Roman engineers did not of course build as solidly as this elsewhere, for they considered, as engineers always have, not only the end to be accomplished but the means and materials available. Some roads in Britain were rather lightly surfaced, some near iron forges were of foundry cinders, and substantial log or

plank roads have been unearthed in Germany. Doubtless many of us, from views of the Appian Way, have formed exaggerated notions as to the smoothness of Roman roads.

The Romans also built harbors for their fleets of galleys. The renowned but ill-fated harbor at Ostia was improved by the emperor Claudius, who, according to Pliny, took what was apparently the largest ship constructed up to that time and sank it by means of concrete blocks, so that it formed a foundation for the breakwater, constituting a crude form of what we now call a caisson.

The Romans were great aqueduct builders. Rome itself was supplied by 14 aqueducts whose aggregate length exceeded 250 miles. Nine of these were well described a century after Julius Caesar's day by the conscientious and methodical water commissioner Frontinus. The aqueducts were built under various Roman officials, beginning with Appius Claudius, and by sundry anonymous engineers, over a period of more than five centuries. The forty or fifty provincial cities of importance each aspired to be a miniature Rome, and also constructed public buildings and a system of aqueducts. The versatile Roman engineers did not make their aqueducts all of the same material or pattern, although in the great majority of cases they used open-masonry conduits plastered inside and resting on one or more tiers of tall stone arches where they crossed valleys. A few are still functioning. The only structure that remains of old Carthage is a partially ruined Roman aqueduct skirting the shores of the Gulf of Tunis.

One of the loveliest and most commonly pictured aqueduct bridges is the Pont du Gard near Nîmes in southern France, built early in the second century. But equally fine is the aqueduct built at practically the same time, under the emperor Trajan's orders, to supply Segovia in central Spain. This aqueduct still serves the city. At what is now Cologne, Germany, are remains of a Roman aqueduct nearly fifty miles long, built of a sort of concrete, which provided the city with water for five or six centuries. Another and much shorter aqueduct at Mainz may have been built by Julius Caesar's engineers, and portions of a Roman aqueduct may still be seen in the southern environs of Paris. At Istanbul (Constantinople) there are also aqueducts nearly as old as those at Rome, notably the aqueduct of Valens, dating back to the division of the empire just after Constantine's day. Its stone came from the walls of a nearby suburb; Valens demolished the walls because he was angered by the town's disloyalty. Istanbul is still using elaborately constructed underground storage reservoirs built more than fifteen centuries ago.

RUINS OF ROMAN AQUEDUCT AT ISTANBUL

The Aqueduct of Valens, Constructed About the Time of the Division of the Empire Following Constantine. From Jean Ebersolt's *Constantinople Byzantine et les Voyageurs du Levant*, Librairie Ernest Leroux, Paris, 1918

THE PUENTE TRAJAN OVER THE TAGUS AT ALCANTARA, SPAIN

Built by the Engineer Caius Julius Lacer About 100 A.D. at the Order of Trajan. Photo by Arthur Byne, from Charles S. Whitney's *Bridges*, New York, 1929

Although Roman engineers were undoubtedly familiar with the principle that water flowing in a closed pipe down through a valley will rise again to its own height on the other side, they employed this principle only rarely, simply because they knew nothing of cast-iron. At Arles, near the mouth of the Rhône, nearly 600 ft of lead pipe, laid probably fifteen centuries earlier in the bed of the river in 40 ft of water, was accidentally brought up by a ship's anchor in the eighteenth century. The pipes are of heavy sheet lead, bent into cylinders, the largest about 6 in. in diameter. This principle of the inverted siphon was also used by the Romans farther up the Rhône at Lyon, where they built four aqueducts. The Roman record for inverted siphons was apparently held by the one at Alatri, near Rome, with its drop of 340 ft, built, it is believed, about 120 B.C.

A volume could be devoted to Roman bridges. Although many a brick arch supported the roofs of royal Mesopotamian tombs centuries before Rome existed, Roman architects and engineers were nevertheless the first to use arches widely and skillfully. Doubtless the oldest European arch extant forms the top of the world's best-known sewer, the Cloaca Maxima at Rome, a covered drain discharging into the Tiber. The Romans apparently built two substantial bridges across the Rhine, at Cologne and at Mainz. In addition, there was Caesar's hastily constructed pile structure, believed to have spanned the river somewhere between Andernach and Coblenz. One of the greatest of Roman architects and engineers, Apollodorus of Damascus, built across the Danube for the emperor Trajan, about 104 A.D., a famous wooden arch bridge with lofty stone piers. Although an entire army worked on its construction for a year, only a few vestiges of the piers remain, and the sole authentic representation of the great structure is a conventionalized bas-relief on Trajan's column at Rome. Curiously enough, this bridge was partially destroyed within a few years by Trajan's successor Hadrian, who feared that if it remained other armies would presently be marching over it in a direction opposite to that which Trajan intended!

A number of important Roman bridges still span Spanish rivers. Another of Trajan's engineers, Caius Julius Lacer, built the lofty bridge over the Tagus at Alcantara. The engineer was buried on the river bank and one may still read the optimistic inscription, *Pontem perpetui mansurum in saecula mundi, Fecit divina nobilis arte Lacer*, that is, "Lacer, a man renowned for his wonderful skill, built this bridge to last forever." One can only pray that Lacer's much-restored bridge has not

or will not become the target of modern high-power explosives.

THE DARK AGES IN EUROPE

With the fall of the Roman empire, her roads, bridges, and water-works systems were so neglected that they soon became practically useless. No one had either the desire or the skill to rebuild anything. But just

OLD LONDON BRIDGE, FROM SOUTHWARK
Built by Peter of Colechurch in 1209, This Massive Structure Endured for 600 Years

after the Crusades came an era of renewed interest in building throughout Europe. This was the period to which a great number of the European cathedrals owe their inception. Except for the cathedrals, however, what has survived of European engineering from 1100 to1500 consists only of some causeway-like stone bridges, many of them built by monks, and pretty well scattered over Europe. Perhaps the most important of these was the old London Bridge with its 19 irregular, pointed stone arches, so solidly designed by the monk Peter of Colechurch, in 1209, that it lasted six hundred years. This was the bridge that "wise men went over, but only fools went under," as the old saying ran. It was also the bridge that was always "falling down"—perhaps, as Jusserand suggests, because various English queens, like Henry III's beloved consort, used the toll moneys for their own upkeep rather than for that of the bridge!

But for nearly 1,500 years the art of bridge building had shown no advancement; there was only endless repetition. In recounting human progress during these years, we of the West are prone to focus our attention so minutely on Europe and the Mediterranean countries that we ignore the rest of the world. One hesitates to affirm that Marco Polo the Venetian could have woven out of whole cloth his tales of the structures he saw in China two hundred years before Columbus crossed the Atlantic. "Over one of these Chinese rivers," so Marco's circumstantial account runs, "there is a most beautiful stone bridge, truly the finest in the world, and without equal. And I will tell you why. You must know that it is no less than 300 paces long and 8 paces broad, with 24 arches, all of gray marble, most excellently worked and put together." With due allowance for all of Marco Polo's optimism, he certainly saw a substantial bridge, which may well have been centuries old in 1290. He also describes a Chinese city—in fact, a whole province—in which the streets were paved with stones and baked bricks, so that one could travel either on horseback or on foot without getting soiled with mud.

At about this time the Incas in Peru developed a unique civilization. Their engineering achievements, which the militant Spaniards did not exert themselves to preserve, were nothing short of marvelous. Perhaps most interesting were their roads, the longest of which stretched 1,200 miles and was smooth enough to be regularly traversed by government messengers in 20 days. According to early Spanish travelers, some of these roads had what we call either bituminous-macadam or lime-concrete surfaces, in spite of the fact that they were intended only for foot-passengers and bea ts of burden, as the Peruvians had no knowledge of wheeled conveyances. How this people quarried their enormous blocks of building stone without iron or steel tools, and how they moved them miles along these mountain roads without wheels is not known for certain. Where these roads crossed gorges, Peruvian engineers built flexible suspension bridges of woven vegetable fiber, some hundreds of feet in span. The larger Peruvian towns were apparently at least as well supplied with water as were most European towns of the period.

While we are speaking of the New World, we should not forget a certain monk called Francisco Tembleque (or Trembleque) who in 1571, only a few years after the Spanish occupation of Mexico, had completed there a noteworthy aqueduct nearly 28 miles long, with its several lofty bridges which are still to be seen. This monk knew more about water than most Europeans of his generation—most people had actually forgotten what Providence intended the liquid for. In the Cologne district it is said that persons of those days, when asked the purpose of the old Roman aqueduct, would shrug their shoulders and reply that it was probably built to bring good Moselle wine down from Trier!

In France, at Sens, where there are copious springs which now supply Paris, there arose one of the few legends whose hero was an engineer. "Once upon a time," it ran, "there was a king of Sens, who, like most kings of that period, had an only child, a lovely daughter. He promised her in marriage to the one among his subjects who should execute the most wonderful work. A wealthy young candidate appeared and offered among other things to cover the town gates with gold. A second lover, less opulent but more ingenious, offered to construct a secret passage from the royal country seat of Vareilles to the town. At the expiration of the period allotted, the richer rival was bankrupt, with his task still incomplete. But the second led the king into the square of Sens, and at a given signal the princess turned a cock which allowed a jet of clear water to rise many feet into the air, to the astonishment of all." The ingenious young man had constructed a subterranean con-

THE SAMARITAINE WATER WORKS ON THE OLD PONT NEUF, PARIS
This Private Venture of Henry of Navarre Was Constructed About 1600 and Dismantled by Napoleon Two Centuries Later

duit from the Vareilles springs, and of course became the father of the king's grandchildren.

A REVIVAL IN CONSTRUCTION WORK

Augsburg, in Bavaria, one of the wealthy and populous towns of Europe in the sixteenth century, seems to have been the first city to pump its supply from a stream flowing through it, using undershot water-wheels turned by the current of the river. Such a system was in operation twenty years later at Toledo, Spain, where the water of the Tagus was somehow pumped to a height of three hundred feet. The latter installation failed to meet expectations, however, and the inhabitants reverted to their more reliable and economical donkeys. Two other pumping systems are better known. Both were built close to the year 1600 by Flemings, an ethnic group that seems to have furnished most of the mechanical geniuses of the day. One supplied London with water pumped by the swift tidal current flowing under one or two of the arches of old London Bridge. Morice's "most artificiall forcier" does not seem to have done much to check the great London fire. In fact his plant was burned, but was restored and then endured even into the nineteenth century. The other was at Paris—the Samaritaine works on the old Pont Neuf, a private venture of Henry IV's to supply his nearby palaces. Napoleon dismantled these works and there is nothing left to recall even the name except a popular department store.

A French hydraulic engineer of this period, Louis de Foix, deserves special mention. Paradoxically, he never completed his most remarkable achievement, the Cordouan Lighthouse in the Bay of Biscay. I believe that he was rewarded for his failure by being clapped into jail by Henry of Navarre, a procedure whose logic is characteristic of the times. Part of his lighthouse is still to be seen by travelers landing at Bordeaux.

JOHN NAPIER, 1550–1617, FATHER OF THE LOGARITHMIC SYSTEM

Travel by water received an enormous impetus in Europe when it became possible to build canals across the ridges separating watersheds. The first canal lock was devised by either an Italian or a Netherlander of the fifteenth century, but France was the first country to develop lock canals on a large scale. Louis XIV was at his best when he allowed Colbert to authorize Peter Paul Riquet to build the Languedoc Canal, which still connects the Mediterranean with the Bay of Biscay, more than a hundred miles away, skirting lovely old Carcassonne en route. Previous to the beginning of the nineteenth century, canal building had progressed only spasmodically in France and England, and a little in Italy, Russia, and Sweden.

I have hitherto spoken of European stone-arch bridges. There were also wooden bridges with short spans and many piers, while draw or bascule bridges, suited to the troublous times, were by no means rare. Palladio, the great sixteenth-century Italian architect, made drawings of wooden trusses with triangular panels, but evidently did not understand how the different timbers functioned in carrying the load. About the middle of the eighteenth century there arose in eastern Switzerland a group of carpenter-engineers, notably the Grubenmann family, who built a number of wooden bridges of fairly long span. Among these were many across the upper Rhine and its tributaries which were so substantial that they might well have stood until now, if the French had not burned nearly every one in the Napoleonic wars.

LÉONARD EULER, 1707–1738, HALF-BLIND MATHEMATICAL WIZARD

BUILDING FOUNDATIONS FOR MODERN ENGINEERING

The seventeenth and eighteenth centuries were remarkable for what they furnished in the way of tools for the engineering science of the nineteenth (I am using the word "tools" in the metaphorical sense). As chemistry and physics were beginning to emerge from magic, these centuries mark the beginning of organized physical experimentation. In this period, too, mathematics became systematized and capable of application to practical matters. This was the work of a great number of men scattered throughout Europe. One can mention only a few, roughly in chronological order. For his everyday logarithms the engineer is indebted jointly to John Napier, aristocratic Scotch scholar, and to Henry Briggs of London. We should not forget picturesque William Oughtred, the "pittiful preacher," who invented the engineer's slide rule in 1621. Calculus emerged full-fledged when Isaac Newton put forth his *Principia* in 1687. One must pass hastily over the French Varignon, who laid much of the foundation for the statics used by the engineer, to mention the great Swiss, Léonard Euler, whose life nearly spanned the eighteenth century and who systematized trigonometry, which had existed in part since the days of Hipparchus, twenty centuries earlier. Euler's column formula is still fundamental to structural engineers; he also developed the theory of turbines long before practical experimenters, led by Fourneyron, were born. Also one should not omit the Swiss Daniel Bernoulli whose fertile brain produced the dynamic theory of hydraulics.

In the field of experimental mechanics one might name four seventeenth-century men to whom civil engineers of our day are especially indebted. Chronologically the first would be Simon Stevin of Bruges, who reasoned correctly concerning the triangle of forces. Next would come the Italian Evangelista Torricelli, he who weighed the atmosphere and therefore understood suction pumps. After him follows Christian Huygens, versatile Dutchman, with his use of the moment-of-inertia concept and his clear ideas on rotating bodies. Finally one should not forget Prof. Robert Hooke, whose claim to fame rests in part on a law which he formulated, and which bears his name. It is fairly accurate, then, to assert that, shortly after the middle years of the eighteenth century, engineering science, including mathematics, mechanics, and to a lesser extent, chemistry, had developed within sight of where it is today, certainly far beyond the modest requirements of the engineers of that generation.

One other fact needs to be noted, namely, that the first school for the training of engineers, the government school at Paris, still called *L'École des Ponts et Chaussées*, was established in 1760. Engineers cannot claim that theirs was a learned profession prior to that year.

Flood Control in New England

Outlining Recommendations of Water Resources Committee and U. S. Engineer Corps

ENORMOUS damage and great suffering resulting from the New England flood of March 1936 focused attention upon the urgent need for flood control in that area. The results of studies made by both the Water Resources Committee and the U. S. Engineer Corps were described in three papers delivered before a meeting of the Northeastern Section of the Society held in Boston on May 5, 1937. Abstracts of these papers are presented herewith.

The first paper, by Professor Barrows, outlines the recommendations of the Water Resources Committee for New England as a whole, compares them with the plans of the U. S. Engineer Corps for the Connecticut and Merrimack basins, and comments upon some of the features of the compacts made by New Hampshire, Vermont, Massachusetts, and Connecticut for distribution of costs other than actual flood-protection construction costs on interstate projects.

The paper by Colonel Young describes the comprehensive plan for 20 reservoirs and 7 dikes developed by the U. S. Engineer Corps for flood control in the Connecticut Valley. The plan embraces only the best of the many reservoir sites and the most economical of the numerous dike locations studied by the Providence District office. Colonel Young's article also discusses in some detail the method of computing direct and indirect losses and benefits.

The third article, by Captain Casey, deals with the studies made by the Boston District office of the U. S. Engineer Corps for flood control in the Merrimack Valley and in the basins of the principal Maine rivers. This investigation indicated that flood-protection construction is economically justifiable at this time on the Merrimack only. For control of this river a system of five reservoirs is recommended, with supplementary river walls and channel improvements.

Water Resources Committee Recommendations for New England

By H. K. BARROWS

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

PROFESSOR OF HYDRAULIC ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASS.; REGIONAL CONSULTANT, NATIONAL RESOURCES COMMITTEE

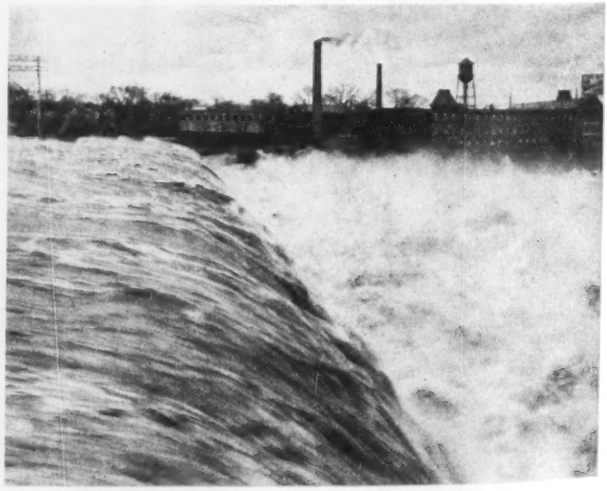
THE most important aspects of flood control in New England today are the flood-control plans now under discussion for the Connecticut and Merrimack river basins, and the interstate compact proposals for carrying out such plans, recently enacted by the legislatures of New Hampshire, Vermont, Massachusetts, and Connecticut.

The flood of November 1927 occasioned a direct loss in New England of about $40,000,000; of which three-quarters was in Vermont. This directed attention forcibly to the consideration of flood-control plans. Vermont, through its Advisory Committee of Engineers on Flood Control, made a very thorough investigation in 1928–1930, covering all the principal rivers of the state, and found that flood control could best be accomplished by reservoir systems developed to a relatively high degree of capacity and built primarily for power use, but affording as a by-product a high degree of flood relief. Flood losses alone would not justify such reservoir systems.

In 1930 the flood committee of the Boston Society of Civil Engineers declared these same general conclusions to be generally applicable to other parts of New England (*Journal* of the Boston Society of Civil Engineers for September 1930). Reservoirs have been constructed at two of the sites selected by the state committee upon the Winooski River, and a third reservoir is now under way.

In 1934–1935 the state of New Hampshire made preliminary studies for flood control by power-storage reservoirs in its Connecticut River tributaries and on the Merrimack River, as a result of which its Water Resources Board was formed to plan and supervise such projects. It is about to construct the first of these reservoirs on the Connecticut River near Pittsburg, N.H.

The great flood of March 1936, which caused damage of over $75,000,000 in New England, largely on the Connecticut and Merrimack rivers, again focused public attention on flood relief. This was a "main-river" flood, causing greatest damage in the larger cities of Massachusetts and Connecticut. In other sections of the East and South much damage occurred, and Congress in the Copeland Act directed the Corps of Engi-



DAM OF THE HOLYOKE WATER POWER COMPANY DURING THE HEIGHT OF THE CONNECTICUT RIVER FLOOD OF MARCH 1936

neers to prepare flood-control plans for numerous rivers, including the Connecticut and the Merrimack.

In 1930, the so-called "308 Report" of the U. S. Engineers for the Merrimack River had recommended no need for flood control. For the Connecticut River, the report (made in February 1936) stated that flood control alone would warrant a federal expenditure of about $5,000,000 only, and that the use of power-storage reservoirs was the only practicable solution of the problem.

Further investigations by the U. S. Engineers on the Connecticut and the Merrimack have proceeded during 1936, and reports and plans were recently submitted to the chief of engineers for consideration. Meanwhile committees have been at work in the four states involved, preparing for submission to the several state legislatures a form of interstate compact under which flood-control plans may be carried out upon the two river systems and the cost of lands and certain other items allocated to the states as required under the Copeland Act.

Such compacts with reference to both the Connecticut and Merrimack river basins have been approved by the legislatures of the states concerned. Approval of these compacts by Congress has not as yet been made.

In 1936 the President also directed the National Resources Committee, through its Water Resources Committee, to review and report upon all water-conservation plans, including flood control, with recommendations as to desirable procedure. This report was made December 1, 1936. The accompanying map (Fig. 1) shows the area covered by the report.

FLOOD-CONTROL PROBLEMS ON THE CONNECTICUT

The Water Resources Committee reported that the outstanding water problem in the Connecticut River basin is that of formulating and carrying out a comprehensive plan for the development of a storage-reservoir system, primarily to serve the needs of power and flood control, and secondarily to insure the dry-season or low-water flow of the main river and its tributaries both in quantity and quality, thus helping recreational uses as well as navigation, and lessening pollution effects.

Flood control is an important problem on the Connecticut. In November 1927, an unusual flood caused damage aggregating about $15,000,000 in the basin, mostly upon tributary streams in Vermont. In March 1936, a much greater flood (probably of 300- to 500-year frequency) caused damages totaling nearly $35,000,000, of which about 85 per cent was on the main river.

A study of flood frequency and damage for the lower river in Massachusetts and detailed determination of average yearly flood damage showed the latter to be about $600,000 for the entire basin. Capitalized at 6 per cent, this gives about $10,000,000 for flood-protection value, to which should be added an allowance for indirect damages. On the other hand, a large part of the damage in both the 1927 and 1936 floods was to highways and bridges, which have been raised since and are not now subject to serious flood damage.

Considering all aspects of the matter, a factor of 1.5 can fairly be used to take account of indirect damage. This factor, applied to $10,000,000, gives about $15,000,000, or possibly $20,000,000, as the limit of justifiable expenditure for flood prevention alone. It therefore appears that flood damage in the Connecticut River basin will not alone justify the expenditure for storage reservoirs which would be necessary to prevent such damage. The solution of the problem lies in the use of reservoirs primarily for power but incidentally to provide a by-product of flood protection. It is assumed, of course, that such reservoirs would be intelligently and adequately operated under the direction of a suitable agency.

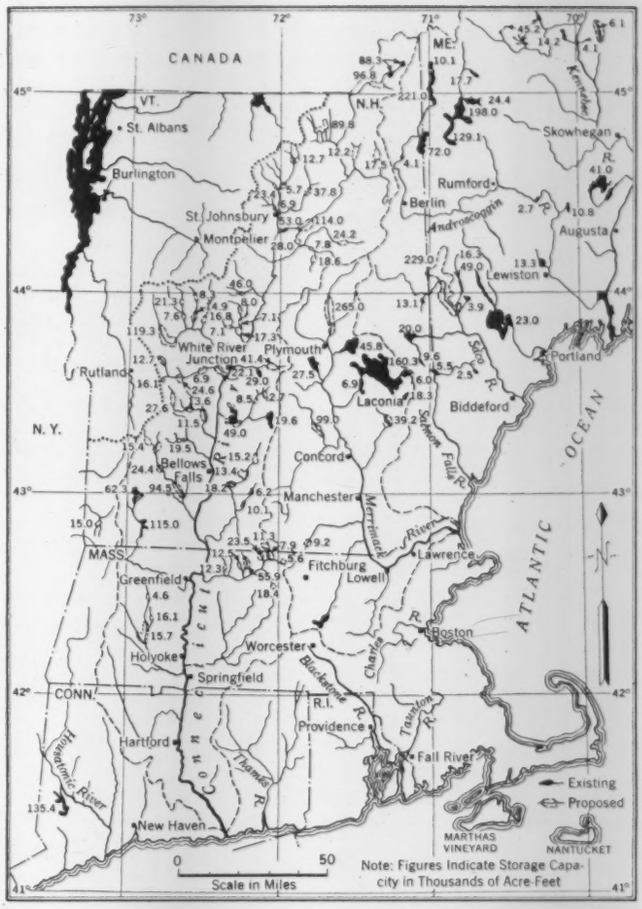


FIG. 1. MAP OF NEW ENGLAND, SHOWING FLOOD-CONTROL AREAS UNDER DISCUSSION

Several different groups of reservoir sites have been investigated. Reservoirs for a fairly complete group of all sites investigated, 59 in number, would cost about $56,000,000 and would control about 57 per cent of the drainage area above Holyoke. On the other hand, reservoirs for an initial group of 8 sites would cost about $13,000,000 and would control about 12 per cent of the area above Holyoke.

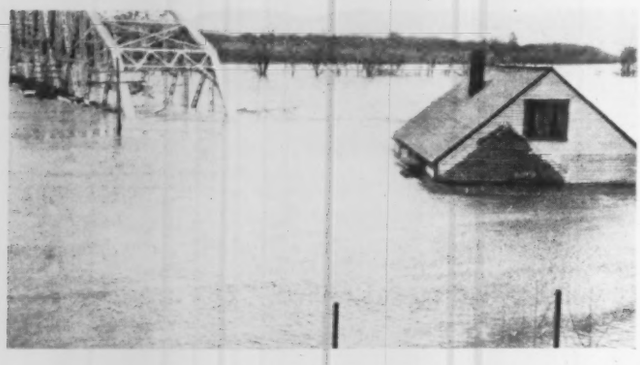
Finally, a group of 37 reservoirs was suggested with about 1,120,000 acre-ft (49 billion cu ft) of storage capacity, controlling, with present available storage, about 53 per cent of the area above Holyoke and costing about $40,000,000. Of this amount, as previously shown, $20,000,000, or one-half, may be justified for flood protection. The remaining $20,000,000 must be carried chiefly by reservoir power values plus the other benefits of increased low-water flow. This increase in the lower river would be 2,500 cu ft per sec or more (from a present amount of about 2,500 cu ft per sec to a regulated flow of about 5,000 cu ft per sec).

POWER DEVELOPMENT ON THE CONNECTICUT

The Connecticut River and several of its tributaries are important in connection with water-power development. The total developed capacity of water power in the entire basin is about 600,000 hp, with 63 plants, which in 1932 generated about 1,500,000,000 kwhr of electrical energy.

A study of power increase due to storage use shows about 170,000 kw of increased capacity (on a 25 per cent

load factor) at developed plants on the main river and its tributaries, and about 340,000,000 kwhr of increased power at these plants. The combined benefits in power use and flood control resulting from such a reservoir system would justify an expenditure of $40,000,000. These power



THE PIERMONT BRIDGE OVER THE CONNECTICUT RIVER NEAR BRADFORD, VT., AT 8 A.M. ON MARCH 20, 1936

benefits would require the absorption of some 340,000,000 kwhr yearly by power users on the main river and tributary plants.

More complete information from surveys or test borings now being obtained by the U. S. Engineer Corps will make possible more accurate cost estimates; and more complete studies of flood routing, reservoir operation, power development, and available power output are also necessary before final selection can be made. With the information now available, however, it is possible to select a list of reservoir projects which would fit into the complete plan, and such a list was appended to the report of the Water Resources Committee. Further investigation as a basis for the final plan is under way by the district office of the U. S. Engineer Corps.

To obtain the full benefits of power storage and such attendant benefits as flood control and lessening of pollution effects, a comprehensive plan of power developments both at reservoir sites and other sites should be investigated, in order that such developments may be carried out as the future increase in power use warrants.

A preliminary review, based on such information as is available, indicates that some 400,000 hp or more of capacity (including the Upper Fifteen Mile Falls site) is available, with a yearly output of upwards of a billion kwhr. Much of the yearly output would be primary power if the comprehensive reservoir system were developed. A complete plan for the river should include such future power developments, and detailed investigation should be made to determine which projects are desirable and to establish a program of priorities.

PROBLEMS ON THE MERRIMACK NOT AS SERIOUS

The Water Resources Committee reported that the outstanding water problem in the Merrimack River basin is similar to that in the Connecticut, that is, the formulating and carrying out of a comprehensive plan for the development of a storage-reservoir system for the purposes there outlined. Sufficient reservoir sites are available upon the various tributaries to provide the degree of regulation required for flood control, power use, and other purposes.

Detailed studies of power-reservoir sites have been made on the Pemigewasset, Suncook, and Blackwater rivers by the state of New Hampshire, and are under consideration by the Water Resources Board of that state. Preliminary studies, without surveys, have been made as a part of this investigation for several other reservoir sites. The U. S. Engineers' "308 Report" gave no conclusive data in this respect.

From the information now available, 9 reservoirs with a total capacity of about 620,000 acre-ft (27 billion cu ft), controlling (along with present available storage, chiefly on the Winnepesaukee River) about 1,650 sq miles of drainage area, or 70 per cent of the area above Franklin and 38 per cent of that at Lawrence, can be constructed for about $18,000,000, of which about 40 per cent can properly be allocated to flood control and the remainder chiefly to power, but with some recreational and pollution-reducing benefits.

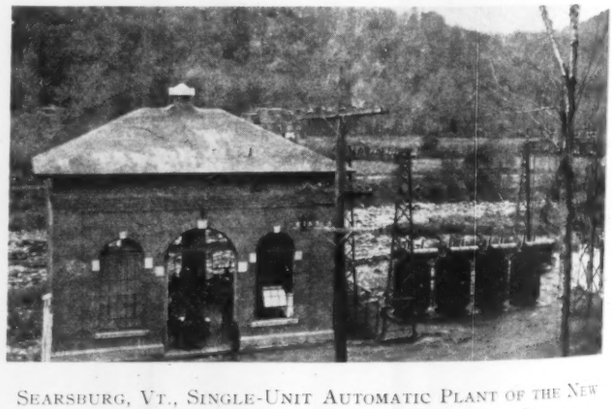
Determination of the final detailed plan awaits further investigations, now under way by the U. S. Engineer Corps. Four reservoirs, already investigated by the state of New Hampshire, totaling about 440,000 acre-ft (19 billion cu ft), can be definitely recommended at this time. All other sites are being left for further investigation, and while preliminary studies of some have been made, further investigation is desirable before a complete system of reservoirs is selected.

For many years the Merrimack River has been highly developed for water power, and the total developed capacity of water power in the entire basin is now more than 200,000 hp.

Opportunities for further substantial development of water-power sites in connection with proposed reservoir sites are found on the tributaries, that is, on the Pemigewasset River, the Contoocook River and its tributaries, and the Souhegan River. Good sites for power development exist in connection with two of the four reservoirs, as well as at various other power sites. A complete plan for the river should include such future power developments, and detailed investigations should be made to determine which projects are desirable and to draw up a program of priorities.

Up to the time of the March 1936 flood, flood damages on the Merrimack River had not been noteworthy. The flood of 1927 caused damages aggregating perhaps a million dollars above Franklin, but was not serious on the lower river. The flood of March 1936 caused direct damages totaling about $20,000,000, principally in the cities of Lowell, Lawrence, and Haverhill. Of this total damage, about 40 per cent was to highways and bridges.

Studies of flood frequency and damage on the Merrimack are unsatisfactory owing to lack of accurate knowledge of damage except for the flood of 1936. From the results of several different analyses, however, it appears that an expenditure of perhaps $8,000,000 to $10,000,000



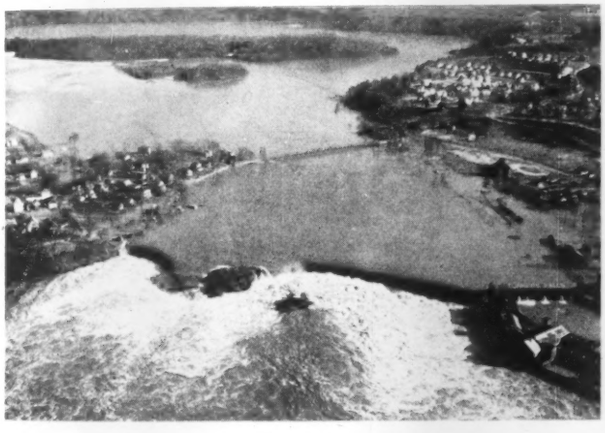
SEARSBURG, VT., SINGLE-UNIT AUTOMATIC PLANT OF THE NEW ENGLAND POWER COMPANY ON THE DEERFIELD RIVER
This Station Utilizes Storage in Somerset Reservoir

is warranted for reservoirs from the point of view of flood protection alone. Hence, as for the Connecticut basin, the desirable procedure is to use the reservoirs primarily for power but incidentally for flood protection.

PLANS OF THE U. S. ENGINEER CORPS REVIEWED

No definite and complete plan has been adopted by the U. S. Engineer Corps for flood protection on the Connecticut, but tentatively some 20 reservoir projects are proposed, controlling 2,000 sq miles of drainage area, or about 20 per cent of the drainage area above Holyoke, Mass., at a cost of about $35,000,000. The total storage capacity would be about 644,000 acre-ft, or a depth of about 6 in. on the controlled area. These are to be for flood-control purposes. About one-third of the group are to be of the retarding-basin type, with outlet conduits and no gates, and the remainder gate-controlled storage reservoirs. Present (or near future) regulation of the upper Connecticut and Deerfield rivers is assumed to control an additional 10 per cent of drainage area above Holyoke. Yearly flood benefits for the whole basin are estimated at $2,066,000 and are 10 per cent in excess of the yearly cost.

Local flood protection by means of dikes is proposed for Hartford, Springfield, and other cities on the lower river. The height of the dikes is based upon a 5-ft freeboard during a flood such as that of 1936, even though a 20-reservoir system is assumed to be in use. An initial plan, incorporated in the proposed interstate compact,



TURNERS FALLS (MASS.) DAM ON THE CONNECTICUT RIVER DURING THE FLOOD OF MARCH 1936

provides for 8 flood-control reservoirs, costing about $13,000,000 and regulating about 7 per cent of the drainage area above Holyoke.

Definite final plans for the Merrimack River have not been completed, but tentatively 5 flood-control reservoir projects, controlling about 1,870 sq miles of drainage area, or about 45 per cent of that above Lowell, are proposed, at a cost of about $17,000,000. Yearly flood-control benefits for the 5-reservoir system are estimated at $932,000 and yearly costs at practically the same. An initial plan, incorporated in the proposed interstate compact, provides for two flood-control reservoirs, costing about $7,000,000, and regulating about 25 per cent of the drainage area above Lowell.

COMPARISON OF PLANS

The plans of the U. S. Engineer Corps for the Connecticut and Merrimack rivers are directed especially toward the end of flood control, and do not adequately take into

FIFTEEN MILE FALLS (N.H.) LOWER DEVELOPMENT ON THE CONNECTICUT RIVER, SHOWING THE COMERFORD STATION OF THE NEW ENGLAND POWER COMPANY

A Typical New England Water-Power Development, Having a Large Storage Capacity of Value for Flood Control

account the important water uses and aspects of power and recreational use and sanitary benefits which will result from a well-regulated and increased low-water flow. On each river reservoir, flood benefits are assumed which are approximately the equivalent of the full direct damage that has occurred in the major flood, this flood being in each case one of extremely rare occurrence. As shown in Table I, a comparison on this basis of Miami Conservancy data with the proposed Connecticut River flood-relief system is of interest.

The cost of dike protection for the lower cities should be added to the cost of the flood-control project on the Connecticut River. This will perhaps add another $10,000,000, making the ratio of total cost to major-flood losses for the Connecticut about 1.28. The ratio for the Merrimack River is 0.85. Again, from the point of view of yearly flood values, the estimates of the U. S. Engineer Corps are nearly double those of the Water Resources Committee on both the Connecticut and Merrimack rivers. These great differences in the fundamental basis for arriving at warranted flood-control expenditure are of great importance and should be reconciled, if possible.

The initial plans—especially for the Connecticut River—will only make a start toward the ultimate goal, and in future it may be difficult to obtain federal funds to complete these projects. It would therefore appear

TABLE I. COMPARISON OF FLOOD-CONTROL PROJECTS

ITEM	MIAMI RIVER	PROPOSED BY U. S. ENGINEERS	
		Connecticut River	Merrimack River
Drainage area, square miles	4,000	8,000	4,000
Major-flood direct losses	$70,000,000	$35,000,000	$20,000,000
Loss per square mile	$17,500	$4,400	$5,000
Cost of control project	$30,000,000	$35,000,000	$17,000,000
Ratio $\left(\frac{\text{cost}}{\text{major-flood losses}}\right)$	0.43	1.00	0.85

wise to utilize every possible means toward their financing, and to allocate benefits to power, recreation, and sanitation, where such benefits will accrue.

In the form of interstate compact now before the state legislatures relating to the Connecticut River, definite specifications are incorporated for 11 reservoirs, of which 8 are to be included in the initial plan. This is unfortunate, as in many cases the size of the dam is limited to

flood-control purposes only. Thus a portion of the reservoir cost at the North Hartland site might well be carried by power uses, but it is definitely provided in the compact that this cannot be done.

The main reservoir proposed for the Merrimack basin, that at Franklin Falls, is in the judgment of the writer inferior to that selected by the New Hampshire Water Resources Board at Livermore Falls. The costs of these are practically the same, but the Franklin site will store only 3.1 in. on 1,000 sq miles, or 3,100 "inch-miles," while that at Livermore Falls will store 12 in. on 408 sq miles, or about 4,900 "inch-miles" of the worst flood-producing area in the basin. The latter also has an excellent power site capable of 60,000,000 kwhr yearly, nearly all primary, at low cost. It will also give flood protection for the river between Livermore Falls and Franklin, where serious damage has occurred.

This also illustrates the advantages of a relatively high degree of storage development, which is fundamental in flood control. As planned by the Water Resources Committee, the complete control of the drainage area will care for about 50 per cent of the average yearly run-off and will provide for flood-control, power, recreation, and sanitation aspects.

The method of flood control proposed by the Water Resources Committee, based fundamentally upon the use of power-storage reservoirs with a relatively high degree of storage capacity, has been in effective use in New England for many years. The regulated areas in the upper reaches of the Connecticut River and on the Deerfield are controlled by storage reservoirs normally used for power purposes, but when so operated they are also found to be highly effective in flood control.

We are building for the long-time future, and public clamor for hurried action should not preclude the formulation of a complete plan, which can be carried out in due season, and which will harmonize with the full and best economic development of these two river basins, thus covering a generous part of New England.

The present situation in respect to flood control is not peculiar to New England. The recent floods on the Ohio and Mississippi, and then within a week in Virginia and Pennsylvania, have caused renewed demands for action. This should be met by the insistence, especially on the part of the engineering profession, that sufficient time be taken to plan thoroughly, wisely, and soundly from an economic viewpoint. Hurried action, without complete and adequate planning, would be most unfortunate, both financially and because of probable future disillusionment as to results.

Army Engineers' Plan for Connecticut Valley

By MASON J. YOUNG

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LIEUTENANT COLONEL, CORPS OF ENGINEERS, U. S. ARMY; FORMERLY DISTRICT ENGINEER, PROVIDENCE, R.I.

THE Engineer Department, U. S. Army, has completed comprehensive field studies in connection with the flood-control problem in the Connecticut River valley following the great flood of 1936, and the studies are now before the Board of Engineers for Rivers and Harbors, Washington, D.C. The recent studies include thorough subsurface investigations of proposed dam sites and dike locations, estimates of costs of reservoirs and dikes prepared with adequate data not heretofore available, an extensive survey of flood losses resulting from the 1936 flood made in cooperation with state and city authorities, and an evaluation of economic benefits to be derived from comprehensive flood protective measures. The Engineer Department studies before and after the 1936 flood indicate that the flood menace within the Connecticut Valley is serious, that the floods can be controlled in a comprehensive and certain manner for a capital expenditure of approximately $50,000,000, and that this expenditure is more than justified. The construction of a comprehensive flood-control project would result in the creation of important additional benefits to hydroelectric power generation, recreation, and to sanitary conditions by reason of increased low-water flows, but the benefits which would result from the control of floods are of controlling importance.

Prior to the flood of March 1936 and the Flood Control Act of June 1936, the Providence Engineer Office had submitted, pursuant to an Act of Congress passed in 1927, what is usually referred to as the Document 308 Report on the Connecticut River valley. This report, published as House Document Number 412, 74th Congress, second session, considered possible improvements in the interests of navigation, flood control, hydroelectric power generation, and irrigation, and was a part of a series of reports covering all the major rivers in the United States. The report recommended an initial flood-control project providing for 10 reservoirs on the Ammonoosuc, Passumpsic, Ompompanoosuc, White, and Ottauquechee Rivers, tributaries of the Connecticut River. This project was recommended as an initial step towards the control of floods within the Connecticut River valley which would give a favorable measure of protection, but not complete or final protection. The project was included in the Flood Control Act of 1936 and has become the existing project authorized by Congress for the Connecticut River valley. During the fall and winter of 1936–1937, the initial project has been restudied and certain modifications have been made in view of additional and more complete information. The modifications are in detail rather than in principle.

THE 1936 FLOOD

The relative magnitude and rarity of the March 1936 flood cannot be overemphasized. The flood record at Hartford, Conn., extends back for nearly 300 years, and

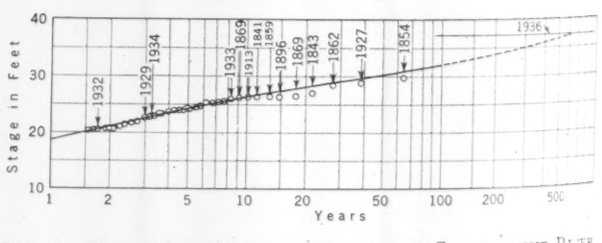

FIG. 1. FLOOD-STAGE FREQUENCY OF THE CONNECTICUT RIVER AT HARTFORD FROM 1883 TO 1936

although fragmentary in the early years, is adequate, I believe, to establish as a fact that there has been no other flood of comparable magnitude during this long period. Figure 1 shows the record for the last one hundred years. The 1936 flood exceeded at Hartford the greatest previous flood of record, that of 1854, by 7.5 ft.

NEW STUDIES AND ESTIMATES FOR RESERVOIRS AND DIKES BEGUN IN 1936

Immediately following the 1936 flood a comprehensive flood-control study of the entire Connecticut watershed was undertaken. The study included a careful review of all previous data and reports bearing upon the flood-control problem, survey work in the field, and particularly subsurface investigations consisting of borings at 33 dam sites, coupled with test pits at the sites and in the borrow-pit areas. Approximately $235,500 and $196,000 have been spent in subsurface investigations and topographical surveys, respectively. It is desired to emphasize the fact that prior to the recent study estimates for most of the dam sites in the valley, including the estimates utilized by the Water Resources and the National Resources committees in their reports submitted in the fall of 1936, were based upon surface investigations only, whereas now data as to subsurface conditions are available for the important locations. New estimates have been prepared in all cases with the benefit of able consulting advice. Estimates for proposed dikes have been prepared after the procurement of data comparable to that secured for dams and with equal care.

Under the terms of the Flood Control Act of 1936, states, cities, or other local interests must pay the costs of lands and damages, including highway and railroad relocations. Estimates of costs falling to local interests have in all cases been prepared in cooperation with the proper local officials; for example, the officials of the state highway commissions in the case of highway relocations. Engineers of the Boston and Maine Railroad reviewed the estimates for two railroad relocations, and I wish to acknowledge their valuable assistance. A special effort has been made to develop thoroughly reliable estimates of all land and damage costs, and engineers throughout the valley have cooperated wholeheartedly to that end.

The study indicates that 30 reservoir sites are of outstanding merit and may be incorporated in future projects for reservoir control. Figure 2 shows the locations, and Table I data, for these sites. In addition, it appears that it may be desirable to protect seven localities in the lower valley by dikes. Table II shows data for the dikes.

Considering the 30 reservoirs, the average cost per acre-foot is $59.60. This average figure is well above the economic limit for hydroelectric power storage projects constructed under the conditions with respect to usable head prevailing within the Connecticut Valley. Thus, only the more economical of the storage projects listed in Table I have power possibilities. The projects can be justified for flood control because of the serious exposure to flood damage and great need for flood protection within the valley.

CHANNEL ENLARGEMENTS

The possibilities for channel enlargements at the Narrows below Middletown, at Pecousic below Springfield, at the Narrows between Holyoke and Northampton, and at the mouth of the Wells River have been studied. These studies are technically very interesting. They indicate that although some small benefits might result from the proposed enlargements, these benefits would be in no way comparable with those to be secured by the construction of reservoirs and dikes.

FIG. 2. PLAN SHOWING RESERVOIR SITES STUDIED IN THE CONNECTICUT VALLEY

Numbers Refer to Sites Listed in Table I

FLOOD LOSSES AND BENEFITS

The study of flood losses commenced on March 22, 1936, the day following the crest at Hartford. On that date field parties started listing major damage throughout the valley and securing preliminary estimates of losses. The field study of flood losses continued for approximately one year. The states of New Hampshire, Vermont, Massachusetts, and Connecticut (through their planning boards and other agencies), all the larger cities and many of the towns, and business concerns in general throughout the valley cooperated in the study. It is impossible to acknowledge in detail the assistance rendered, but it was an essential part of the study and was of the highest value. The study of flood losses established the basis for evaluating anticipated benefits to be derived from proposed reservoir and dike projects. Benefits were studied under three headings.

Direct benefits are those resulting from the elimination of direct damage to property and the cost of clean-up to private and governmental interests. Direct losses and benefits have been studied by breaking down the main stem of the river below the mouth of the Passumpsic River into 10 reaches and the various tributaries into reaches as required. The study involved a total of 49 reaches. The direct losses were determined for the 1927 and 1936 floods as accurately as possible. It appears that direct losses resulting from the 1936 flood of a recurring and preventable character below proposed reservoir sites totaled $31,065,000.

Indirect benefits are defined as those resulting from the

elimination of indirect losses which include losses of business and the increased cost of doing business to persons and organizations, private and governmental, as a result of floods, both in the flooded area and outside the flooded area. The indirect losses were very broadly distributed and many firms at a distance from the Connecticut Valley suffered. A separate estimate based upon many investigations and a large accumulation of data has been made of the indirect losses for each of the various reaches. Averaging losses of all types for all the reaches, the indirect losses are estimated to bear a ratio to direct losses of 94.5 per cent.

The third item results from restoration of property values depreciated by reason of flooding. This item is applicable to private property only and is measured by the loss in market value of properties within the flooded areas. The depreciation of property values as a result of the 1936 flood was very great, and the estimates of this depreciation have no direct relation to the direct losses. The depreciation is not a part of, or included within, the estimates of direct and indirect losses. The estimates of depreciation are based upon the detailed study of the various reaches. Investigators made a careful determination of the assessed value of the property flooded in 1936 below the proposed reservoir sites and found it to total $330,816,250. Depreciation has been determined by a careful canvass of the few sales that have been made subsequent to the 1936 flood, and by a canvass of banking practices in connection with flooded property and the opinions of bankers and real estate operators. The estimate of depreciation is $74,857,000; the ratio of depreciation to assessed values ranges from 10 to 75 per cent and averages 22.5 per cent. It is further estimated that comprehensive protection involving dikes and reservoirs could restore 80 per cent of these values. In many localities the property would be restored not only to its value previous to 1936, but to a higher value by reason of its being made suitable for industrial or other preferred use. It is felt that the estimate of 80 per cent restoration of property values is conservative.

The character of the losses discussed may be illustrated by assuming a rented residence at Springfield or Hartford assessed prior to March 1936 at $5,000 and having an actual sale value of approximately that amount. Let us assume that it was flooded seriously and that it

TABLE I. RESERVOIR DATA, CONNECTICUT RIVER VALLEY

Identification No.	Name of Reservoir	Stream	Drainage Area in Sq Miles: Gross Above Dam	Drainage Area in Sq Miles: Net Controlled by Dam	% of Drainage Area of Conn. River Controlled by Dam	Type of Reservoir Control	Spillway Elevation M. s. l.	Height of Dam (Ft)	Flood-Control Capacity: Acre-Ft	Flood-Control Capacity: In. of Run-off	Area at Spillway Elevation (Acres)	Cost to United States	Cost to Local Interests	Total Cost of Reservoir	Cost per Acre-Ft	Cost per Sq. Mile of Drainage Area
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
18A	East Haven*	Passumpsic River, Vt.	47.5	47.5	0.42	Retarding	1,040.0	103	15,500	6.1	500	$1,189,000	$284,400	$1,473,400	$95.00	$31,000
21A	Lyndon Center*	Millers Run (Passumpsic), Vt.	52	52	0.46	Retarding	766.5	79	16,600	6.0	550	776,000	446,500	1,222,500	74.00	23,500
22A	Victory*	Moose River (Passumpsic), Vt.	66	66	0.59	Retarding	1,149.0	47	24,600	7.0	1,820	367,000	264,000	631,000	26.00	9,600
50	Harvey Lake*	Stevens River, Vt.	24.9	24.9	0.22	Retarding	900.0	37	7,800	5.9	438	163,000	121,100	284,100	36.00	11,400
24A	Bethlehem Junction*	Ammonoosuc River, N.H.	90	90	0.80	Retarding	1,356.0	163	28,800	6.0	860	2,146,700	537,400	2,684,100	93.00	29,800
26	Gale River	Gale River (Ammonoosuc), N.H.	86	86	0.77	Retarding	912.0	92	13,400	2.9	470	833,000	292,200	1,125,200	84.00	13,100
69	Bath	Ammonoosuc River, N.H.	397	397	3.54	Retarding	600.0	160	127,000	6.0	2,500	4,547,500	4,547,500	9,095,000	72.00	22,900
27A	Groton Pond*	Wells River, Vt.	17.3	17.3	0.15	Retarding	1,085.0	19	6,500	7.0	560	65,000	51,000	116,000	18.00	6,700
28A	South Branch*	South Branch (Waits), Vt.	45	45	0.40	Retarding	810.0	95	14,400	6.0	520	489,000	211,000	700,000	49.00	15,600
48	Union Village*	Ompompanoosuc River, Vt.	126	126	1.12	Gates	543.0	155	30,200	4.5	600	1,726,000	217,900	1,943,900	64.00	15,400
29A	Gaysville*	White River, Vt.	226	226	2.01	Gates	795.0	170	77,800	6.5	1,800	1,725,300	1,725,300	3,450,600	44.00	15,300
30A	Ayers Brook*	Ayers Brook (White), Vt.	30	30	0.27	Retarding	695.0	70	9,800	6.0	560	393,000	340,800	733,800	75.00	24,500
49A	South Tunbridge*	First Branch (White), Vt.	102	102	0.91	Gates	553.0	88	24,500	4.5	750	1,005,000	767,000	1,772,000	72.00	17,400
70	Centerville	White River, Vt.	692	692	6.17	Gates	508.0	175	155,000	4.2	3,300	4,860,000	4,860,000	9,720,000	63.00	14,000
66	West Canaan	Mascoma River, N.H.	80	80	0.71	Gates	893.0	53	25,700	6.0	1,370	888,000	888,000	1,776,000	69.00	22,200
72	Mascoma Lake	Mascoma River, N.H.	153	73	0.65	Gates	759.0	40	17,000	4.4	1,620	471,000	471,000	942,000	55.00	12,900
63	North Hartland*	Ottauquechee River, Vt.	222	222	1.97	Gates	528.0	153	48,500	4.1	900	2,704,000	158,000	2,862,000	59.00	12,900
53A	Stocker Pond	Stocker Brook (Sugar), N.H.	35.4	35.4	0.32	Retarding	1,032.0	48	11,300	6.0	1,060	254,800	254,800	509,600	45.00	14,400
64A	Claremont*	Sugar River, N.H.	245	245	2.18	Gates	607.0	105	60,000	4.6	1,370	2,571,000	1,507,000	4,078,000	68.00	16,600
36	Ludlow	Black River, Vt.	56	56	0.50	Gates	1,057.0	83	13,400	4.5	640	836,000	641,500	1,477,500	110.00	26,400
74	Perkinsville	Black River, Vt.	142	142	1.27	Gates	635.0	119	46,200	6.0	1,350	2,367,000	1,047,000	3,414,000	74.00	24,000
55A	No. Springfield*	Black River, Vt.	156	156	1.39	Gates	519.0	83	26,500	3.2	835	1,057,000	224,200	1,281,200	48.00	8,200
40A	Newfane*	West River, Vt.	326	326	2.90	Gates	486.0	141	105,000	6.0	2,130	3,240,000	1,273,500	4,513,500	43.00	13,800
57A	Surry Mountain*	Ashuelot River, N.H.	100	100	0.89	Gates	541.0	76	32,000	6.0	1,150	1,295,000	325,100	1,620,100	51.00	16,200
59	Lower Naukeag*	Millers River, Mass.	19.7	19.7	0.17	Gates	1,076.0	30	5,400	5.1	650	298,000	131,000	429,000	79.00	21,800
60	Hydeville	Millers River, Mass.	85	65.3	0.58	Gates	875.0	65	14,700	4.2	850	604,000	143,600	747,600	51.00	11,400
61A	Priest Pond	Priest Brook (Millers), Mass.	18.8	18.8	0.17	Gates	879.0	44	6,000	6.0	500	325,000	97,100	422,100	70.00	22,400
65	Birch Hill*	Millers River, Mass.	176	156.3	1.39	Gates	847.0	59	50,000	6.0	3,150	1,263,000	1,263,000	2,526,000	50.00	16,200
62A	Tully*	Tully River (Millers), Mass.	50	50	0.44	Gates	668.0	65	21,300	8.0	1,125	423,000	150,800	573,800	27.00	11,500
47	Knightville*	Westfield River, Mass.	164	164	1.46	Gates	596.0	140	39,300	4.5	860	1,364,000	576,000	1,940,000	49.00	11,800
	Totals		3,911.2	34.82					1,074,200	5.1		$40,246,300	$23,817,700	$64,064,000	$60.00	$16,400

* Included in comprehensive plan study.

cost the owner $750 to restore the property to its pre-flood condition. This item pertains to the direct loss. Let us next assume that the tenant had to move out, suffering a direct-loss item on his furniture and personal property of $250, and an indirect-loss item of $500 resulting from loss of employment and additional cost of maintaining his family at a distant locality. Let us further assume that the property was repaired and the owner, wishing to liquidate, found that he could sell for only $3,000. In point of fact, this depreciation in value of 40 per cent is moderate for the type of property under consideration. Summarizing, the losses are: direct, $1,000; indirect, $500; depreciation, $2,000; total, $3,500. The depreciation losses are one of the compelling reasons behind the insistent demands from valley interests for flood protection, and a reason that cannot be set aside.

ACTION BY STATES AND CITIES IN CONNECTION WITH LANDS AND DAMAGES

Under the terms of the Flood Control Act of June 1936, local interests must provide lands and rights of way, protect the United States against all damages, and operate and maintain the completed flood-control works. The second proviso means that local interests must relocate highways and railroads, the relocation of highways being the most expensive damage item. Thus, the Act contemplates that the United States shall assume the responsibility of flood-control construction, and that local interests, towns, cities, or states, shall meet the costs additional to the actual construction costs.

Present plans contemplate that New Hampshire, Vermont, Massachusetts, and Connecticut shall bear the costs falling to local interests in connection with reservoirs, and that the various cities and towns in the valley receiving protection by dikes shall bear the local costs in connection with the dikes. A compact was negotiated in April 1937 between the four states, providing distribution of costs in connection with reservoirs as follows: New Hampshire, 5 per cent; Vermont, 5 per cent; Massachusetts, 50 per cent; and Connecticut, 40 per cent. The compact did not receive the approval of Congress at the last session and will not become effective until it is approved by Congress.

COMPREHENSIVE FLOOD-CONTROL PLAN STUDY INVOLVING RESERVOIRS AND DIKES

In connection with the negotiation of the compact, a Comprehensive Food Control Plan involving reservoirs and dikes was set up and analyzed so that the negotiators might know approximately the financial responsibilities of the United States and the states in connection with the protection of the valley as a whole, and the probable results. This plan includes 20 reservoirs selected from the 30 shown in Table I, with a view to securing a maximum of flood protection at a minimum cost, plus dikes at 7 localities as shown in Table II. The plan approximates the costs and results to be expected from a general protection of the Connecticut Valley. It must be recognized, however, that changes in the reservoirs selected for inclusion in the ultimate plan may be anticipated, and that as the valley develops industrially, it is probable that dike protection can be justified at points additional to the seven which are shown in the accompanying Table II.

The comprehensive plan was the basis for the provisions in Article X of the compact which read:

> The initial plan for the construction of eight reservoirs herein mentioned and provided for is part of a long-range comprehensive program for flood control on the Connecticut River and its tributaries, the object and purpose of the signatory states being to enlarge and expand such flood control projects to an ultimate control, including the reservoirs hereinabove mentioned of approximately twenty-one per cent of the drainage area thereof, at a total maximum cost to the signatory states, including the cost herein specified, of not to exceed Ten Million Five Hundred Seventy-five Thousand (10,575,000) Dollars, and the contributions by the respective signatory states, in the proportions hereinbefore set forth, shall not in any event exceed the total amount above stated.
>
> In the further development of such comprehensive program, said commission shall determine from time to time the site, character, location and extent of such additional reservoirs, subject to the approval of the legislature of the state in which the same may be located.

Thus, the Connecticut River Valley Flood Control Commission, when established under the terms of the compact will control in behalf of local interests the selection of

TABLE II. GENERAL DIKE DATA

Locality	Type of Dike	Approx. Height of Dike (Ft)	Approx. Length of Dike (Ft)	Approx. Area Protected (Acres)	Character of Area Protected	Assessed Valuation of Area Protected	Total Direct Flood Losses in Area Protected (1936)	Cost to United States for Construction	Costs to Local Interests: Rights of Way and Damages	Costs to Local Interests: Pumping Plants and Drainage Appurtenances	Costs to Local Interests: Total	Total Cost	Ratio Total Cost to Assessed Val. (%)	Ratio Total Cost to 1936 Direct Flood Loss (%)
Hartford	Concrete wall & earth fill	20	21,000	2,755	Railroad, Industrial, Commercial, Residential	$135,600,000	$7,330,000	$4,700,000	$315,000	$525,000	$840,000	$5,540,000	4.1	75.6
East Hartford	Earth fill & concrete wall	20	15,000	582	Railroad, Commercial, Residential	8,454,000	1,324,000	845,500	202,500	233,000	435,500	1,281,000	15.2	96.8
Springfield	Earth fill & concrete wall	10	12,000	819	Railroad, Industrial, Commercial, Residential	75,329,000	3,701,000	590,000	66,000	1,158,000	1,224,000	1,814,000	2.4	49.0
West Springfield	Earth fill & concrete wall	12	16,800	1,044	Industrial, Commercial, Residential	16,048,000	2,854,000	225,000	11,000	30,000	41,000	266,000	1.7	9.3
Chicopee	Earth fill & concrete wall	10	24,000	1,020	Industrial, Commercial, Residential	5,909,000	871,000	680,000	58,000	569,000	627,000	1,307,000	22.1	150.1
Holyoke	Concrete wall & earth fill	10	17,400	105	Industrial, Residential	11,720,000	774,000	1,203,500	123,500	160,000	283,500	1,487,000	12.7	192.1
Northampton	Earth fill & concrete wall	15	11,600	175	Small Commercial, Residential	2,716,000	438,000	318,000	39,000	113,000	152,000	470,000	17.3	107.5
Total			117,800	6,500		$255,776,000	$17,292,000	$8,562,000	$815,000	$2,788,000	$3,603,000	$12,165,000	4.8	70.4

future reservoir sites subject to the consent of the state in which each reservoir may be located.

The Flood Control Act of 1936 places upon the Engineer Department responsibility for engineering plans and construction in connection with flood-control measures throughout the United States. Flood-control projects are under the law necessarily cooperative between the federal government and the local interests. The duty of the Engineer Department is to develop the best possible flood-control plans for the various river valleys throughout the United States and to present them to Congress in their true economic light. If Congress acts favorably upon the recommended plans, they become federal projects.

The flood-producing area within the Connecticut Valley extends from the Fifteen Mile Falls development, or the mouth of the Passumpsic River, to the Farmington River. Above the Passumpsic River, flood crests do not develop in time to superimpose upon the damaging flood crests in the lower river. This fact can be established by study of the valley and is confirmed by experience in 1927 and 1936 and in many other floods. As shown in Fig. 2, the reservoirs are well distributed throughout the flood-producing area, and it is possible with about 20 of them to afford general protection to both the main river valley and the valleys of the more highly developed tributaries. The areas already controlled by water-supply and power-storage reservoirs, which have large capacity with respect to their drainage areas, assist materially. In connection with the selection of flood-control reservoir sites, the important considerations are the extent of the controlled area and distribution.

Extensive studies have been made to determine the capacity that must be provided for the control of a drainage area. It appears that this capacity should be sufficient to hold from 6 to 8 in. of runoff. Owing to physical limitations, some of the proposed reservoirs have less capacity than that required to retain 6 in. of runoff. It has been found undesirable to go below a capacity equivalent to $4\frac{1}{2}$ in. of runoff.

Considering dikes, last summer President Roosevelt provided approximately one-half million dollars for dike construction in the lower Connecticut River valley from relief funds. With this money the Engineer Department has raised and extended existing dikes at Hartford, Springfield, and West Springfield and has closed large gaps in earlier dikes and in the river banks at Hadley and Hatfield. Thus, an actual start has been made on a federal flood-control project in the lower Connecticut Valley, although the construction of dikes by the federal government has not been formally authorized by Congress. The studies indicate that reservoirs can afford a satisfactory degree of protection for agricultural and the less highly developed areas, but that they should be supplemented by dikes to afford complete protection to the highly developed urban areas. The possibility of providing general protection by dikes alone has been considered, and the cost of providing general dike protection for exposed localities in Massachusetts and Connecticut has been approximated. It appears that such general protection would cost about $43,000,000 and that the benefits to be secured would not be comparable with those resulting from a combined reservoir and dike project.

There is a large element of judgment involved in the selection of reservoirs to be included in a comprehensive plan for the valley. The selection of the localities for dike protection is an easier matter. The comprehensive plan considered by the compact commissioners and discussed in this paper utilizes the best of the reservoir sites and the most economical dike locations. Reservoirs give a general protection to developments both along the main stem of the river and upon important tributaries, and consequently are preferable to dikes in so far as reasonably economical sites can be found. Generalizing, within the Connecticut Valley dam sites are good, but the capacity of the reservoirs is limited by reason of the steep and narrow valleys. Locations are limited by existing roads, railroads, and towns. It is not possible to secure as complete a measure of reservoir control as is desirable because of these conditions.

The reservoirs included in the comprehensive plan study are indicated in Table I. The percentage of area controlled, considering both the proposed flood-control reservoirs and the existing water-supply and power-storage reservoirs, is, for Springfield, 31.3 per cent if the entire valley above the city is considered, and 35.8 per cent if only that portion of the valley below the Passumpsic River is considered. The estimates for this plan are as follows:

	Construction Costs United States	Land and Damages, Local or State Costs
Reservoirs	$24,260,000	$10,575,000
Dikes	8,562,000	3,603,000
Total	32,822,000	14,178,000
Ratio, per cent	70	30
Grand total	$47,000,000	
Annual cost	$ 2,729,000	

The above annual cost is figured at 4 per cent interest on federal expenditures and 5 per cent interest on local expenditures. Obviously the rates of interest are high and the modification in the picture that would result from utilization of a 3 per cent interest rate, which is more in accordance with existing financial conditions, will be indicated later.

Considering the value of the flood protection afforded, the reservoirs alone would eliminate practically all damage from floods of a magnitude of those of 1854, 1863, and 1927, the three greatest floods of record except that of 1936, and the dikes are required only to control satisfactorily floods of the order of that of 1936. In case the entire project should be constructed and then the 1936 flood should recur, the flood would be passed at Springfield and Hartford with a freeboard of approximately 5 ft or more on the dikes. This freeboard represents the factor of safety on a very great and very rare flood of the order of that of 1936. Dike heights have been established on a basis of a 3-ft freeboard over and above flood levels for a maximum predicated flood. There is no definite and satisfactory manner of arriving at the maximum possible flood for any point in the watershed, but the estimates by the Providence Office indicate that the maximum probable flood should be about $2\frac{1}{2}$ ft higher in the vicinity of Springfield and Hartford than the flood of 1936.

The computation of annual benefits based upon a comprehensive plan including the 20 selected reservoirs and dikes at 7 localities is summarized as follows:

Annual benefits:	
Direct	$ 854,400
Indirect	816,400
Restoration of property values	3,597,200
Total annual benefits	$5,268,000
Ratio, benefits to costs	1.93

The assignment of benefits to reservoirs and dikes is a matter of judgment. Actually most of the direct and in-

direct benefits have been credited to the reservoirs and most of the benefits resulting from the restoration of property values have been assigned to the dikes. It is believed that these allocations are reasonable and that the estimate of total benefits will withstand searching analysis.

THE CONNECTICUT AT HADLEY AND HATFIELD, MASS., ON MARCH 21, 1936

As already stated, annual costs have been figured both on a basis of 4 and 5 per cent for federal and local costs, respectively, and also on a basis of 3 per cent. In both cases the computations provide for amortization in 50 years. Construction costs involve a substantial percentage to offset anticipated rising prices. This percentage should properly be eliminated to make costs comparable with benefits figured on the 1936 price level. In addition, the estimates for each reservoir and each dike locality include a substantial percentage for contingencies. It is felt, however, that considering a large group of projects only one-half this contingency factor should be allowed for the purposes of comparison with benefits because it is not anticipated that all projects will utilize the entire contingency factor when actually constructed. Allowing for these changes, the ratio between benefits and costs becomes 2.47 instead of the original figure of 1.93.

In addition to the evaluated benefits, there are important unevaluated benefits. All estimates have been based upon amortization within 50 years, whereas it is confidently expected that any flood-control construction will be highly valuable at the end of the amortization period and may be more valuable than it was at the time of construction on account of increased development of the valley. There are also important advantages to be derived from the diversion of protected areas to preferred and more valuable uses, the storage of water for the benefit of hydroelectric power generation, the provision of recreation pools, and the provision of stored water for the improvement of low-water flows and sanitary conditions. There is an anticipated minor benefit to navigation in the stretch between Hartford, Conn., and Long Island Sound.

BENEFITS TO HYDROELECTRIC POWER GENERATION

It must be borne in mind that within the Connecticut Valley the best sites have been utilized and the valley is now extensively developed for the benefit of power. Power pools are nearly continuous from Holyoke, Mass., to above White River Junction. In the upper valley, there is the important Fifteen Mile Falls development, with an installed capacity of 150,000 kw supplemented by the Connecticut Lakes storage. It is expected that the Pittsburg development will be added soon. Further development for power in the Connecticut Valley must, I believe, be restricted to a limited number of sites and designed to supplement the already important development. The possibilities of the various flood-control reservoirs in connection with power development have been carefully studied, and it appears that there are several sites at which conservation storage may be secured economically. Stating the results of study in general terms, the construction of the flood-control project will facilitate the development of sites for power, and, it is believed, will make the provision of power-storage capacity economically feasible at several localities where it otherwise would not be feasible.

The reasons for the proposed utilization of the North Hartland site for flood control alone have been a matter of discussion. Reference to Table I and Fig. 2 shows that this site controls 222 sq miles in the central portion of the flood-producing area. There is no alternative site that will control the same area in whole or in part and is acceptable to Vermont. The height of flowage and reservoir capacity are subject to physical limitations, so that the site affords storage for only 4.1 in. of runoff. Consequently, there is no possibility of surplus capacity for power storage. Capacity costs $59 per acre-ft. This figure is justified economically for flood-control storage because of the importance of the control the site affords, but is far above the value of an acre-foot of power storage at the North Hartland location.

RECREATION

It is felt that too little attention was given in the Document 308 Report to the important question of recreation. The commissioners negotiating the compact had this consideration very much in mind. It appears possible to provide recreation pools of considerable area in some of the flood-control reservoirs during the summer period, thereby making them particularly attractive to summer visitors and offsetting the economic loss that may result from the utilization of agricultural lands for reservoir purposes.

COMPARISON WITH THE MIAMI CONSERVANCY PROJECT

A comparison of a Comprehensive Plan for the Connecticut Valley (consisting of 20 reservoirs and dikes at 7 localities) with the Miami Conservancy District Project is instructive. The Miami project resulted from the great flood of 1913, and the construction work actually commenced in 1918. A survey following the 1913 flood indicated losses by reason of depreciation of real estate values comparable to those found in the Connecticut Valley after the 1936 flood. The following tabulation is significant:

	Connecticut Project		Miami Project
Drainage area, square miles	11,260		5,385
		Dayton	201,000
		Middletown	30,000
		Hamilton	52,000
Population	1,228,390	Total	283,000
Type of project	Reservoirs and dikes	Reservoirs, channel improvements, and dikes	
Cost	$47,000,000	Approx.	$43,000,000

During the past 20 years the Miami Valley, and the city of Dayton in particular, have had a wonderful development. It would be hard to find a representative businessman or banker in the Miami Valley who feels that the conservancy project has been a bad investment.

The studies of the Connecticut River valley made both before and after the great flood of 1936 indicate that:

Floods within the Connecticut Valley can be adequately controlled.

The economic justification for a flood-control project is very strong, and consequently the project should be pushed to early completion.

There are numerous important incidental benefits to hydroelectric power generation, to recreation, and to sanitary conditions by reason of increased stream flow to be secured in connection with the flood-control developments, but the benefits resulting from the control of floods predominate.

A comprehensive flood-control project will give the inhabitants and business within the Connecticut Valley a security they badly need and have never had.

The Document 308 Report on the Connecticut River valley, submitted prior to the 1936 flood, was proposed by the writer, who was also responsible for the studies and report prepared after the flood and discussed in this paper. Howard S. Gay, M.Am. Soc. C.E., was in charge of the earlier Document 308 studies. Harold E. Libby participated in the preparation of the final Document 308 Report. Clarence E. Boesch, M.Am. Soc. C.E., was directly in charge of the studies and the preparation of the report subsequent to the 1936 flood. Joel D. Justin, M.Am. Soc. C.E., participated in the preparation of the estimates for dams and reservoirs in a consulting capacity.

Army Engineers' Plan for Merrimack Valley and Principal Maine Rivers

By HUGH J. CASEY

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THE flood of March 1936 was the most damaging in the history of New England. Within a few days after this flood, the federal government took action. The U. S. Engineer Corps was called upon to review previous "308" reports submitted on the major river basins, including (for the Boston District) the Penobscot, Androscoggin, Kennebec, Saco, and Salmon Falls rivers in Maine, and the Merrimack River in New Hampshire and Massachusetts. The principal features of these watersheds are shown in Fig. 1.

In the meantime, a flood-control omnibus bill was passed and approved June 22, 1936, enunciating for the first time a federal policy for comprehensive flood control for the entire country. It authorized some $300,000,000 of flood-control projects, including one for the control of floods on the Merrimack River by reservoirs at an estimated construction cost of $7,725,000, with estimated land and damage costs of $3,500,000. This act provided for certain local cooperation from the interests benefited, which, it is felt, furnishes an excellent check on the extent of flood control which the federal government should be called upon to carry out. Otherwise, wholesale demands would be made for flood control, irrespective of the economics involved. It is also proper that the local interests should pay a part of the cost inasmuch as the major part of the benefits accrue to them.

No appropriation was made in connection with the Flood Control Act, but it is practically assured that a large allotment sufficient to begin construction on two of the important flood-control reservoirs in the Merrimack basin will be made, provided, of course, that the measures regarding local cooperation will have been met. An interstate compact has already been passed by the legislatures of the states of Massachusetts and New Hampshire, providing for the necessary local cooperation incident to the construction of two of the reservoirs, the Franklin Falls and the Blackwater.

Flood-control surveys over the six river basins assigned to the Boston District were conducted generally as described below. Previously reports made by the U. S. Engineer Corps and other agencies were assembled and reviewed for consideration of the various reservoir and other flood-control possibilities. The U. S. Geological Survey maps and other available maps covering the river basins were scanned for every potential flood-control reservoir site, and preliminary analyses as to capacities and costs were made. Those flood-control reservoirs which still appeared feasible were then flown by the Army Air Corps, which took vertical aerial photographs on a scale of approximately 1:10,000. Reservoirs selected from this group on the basis of field examination and reconnaissance were then surveyed by our field survey forces, using the enlarged aerial photographs as base sheets.

Meanwhile all available hydrological and hydraulic information pertaining to rainfall, snow, and river discharge was being assembled. Extensive studies were made of the types and paths of storms which resulted in moderate to severe floods in New England. Isohyetal charts for the various storms and time-area-depth curves covering the rainfall for the various record storms were prepared. Frequency studies for precipitation and discharge at various rainfall and discharge stations of long record were also made. Information was assembled on channel capacities at critical sections, together with the channel storage contained in various reaches. The latter information was necessary to determine the effect of a reservoir system on the reduction of past and planned floods, including allowances for the reducing and retarding effect of channel and valley storage.

Since one of the first determinations which must be made prior to instituting any plan for flood control over a particular basin is the determination of its value, it was necessary to know the frequency of floods over various reaches in that basin and the extent of flood damages resulting from floods of various stages. From a combination of the stage-frequency and damage-frequency curves for various reaches, it was then possible to determine the probable annual flood loss, and hence the upper limit of economic justification for flood control. Typical damage-discharge and damage-frequency curves for the lower Manchester reach of the Merrimack River are shown in Fig. 2.

SELECTING THE METHOD OF FLOOD CONTROL

It was next necessary to determine the various methods of flood control, within the economic limits previously determined, which may be applied for the reduction or prevention of flood damage in the area concerned. There are in general four methods of flood control: Reservoirs, levees or river walls, channel improvements, and diversion.

Reforestation is included by many as a very effective means of flood control. In the public press and on the radio, one often hears the charge that deforestation is the major factor in causing the recent severe floods. But although I fully endorse the need for reforestation as insurance for a continued supply of timber; as a means of controlling and preventing erosion, particularly on steep hillside slopes; for its scenic and recreational value; and for many other reasons, I do not feel that any measure of reforestation will be of material value for flood control.

History bears out the fact that many years ago, before deforestation had become at all effective, major floods occurred on our important river systems. After the trees and beds become saturated, or when the ground and its cover are frozen, the storage and retarding effects of forests are slight. Furthermore, in so far as the Merrimack River basin is concerned, it is estimated that the state of New Hampshire is at present forested over approximately 80 per cent of its area. The potential increase in forestation is therefore limited. Improvement, if any, would have to consist in replacing deciduous trees with the non-deciduous variety for greater storage effect.

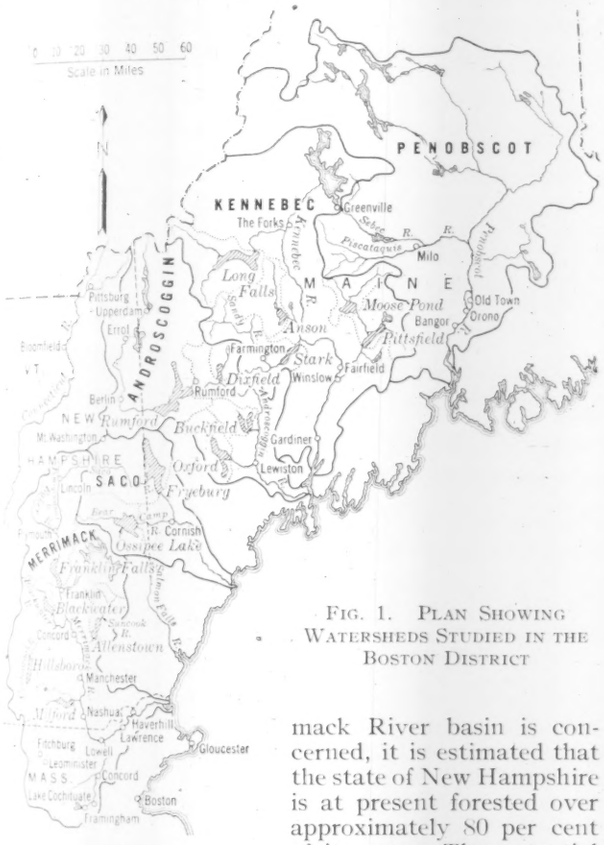


FIG. 1. PLAN SHOWING WATERSHEDS STUDIED IN THE BOSTON DISTRICT

The most desirable of the four methods of flood control is that by reservoirs, but tremendous storage capacity is, of course, necessary. In a developed basin, moreover, it is difficult to find the necessary reservoir storage within economic limits, as the most desirable storage sites are already occupied by power or power-storage developments, and the potential reservoir basins are apt to be occupied by communities, railroads, and highways, all of which involve high damage costs for relocation. An extensive system of reservoirs is very costly, and with funds made available on a long-term program, complete flood control for a community located near the mouth of a river will not be attained until completion of the entire system.

With reference to the determination of preliminary cost estimates for reservoir control, I suggest the use of a relatively simple formula for determining the extent of the control necessary, as follows:

Drainage area in square miles × 160 = Acre-feet of flood-control storage required

This formula is based on provision of a distributed reservoir capacity controlling 50 per cent of the drainage basin, with sufficient storage to hold a 6-in. runoff over the controlled area. In a developed basin, cheap flood-control storage will cost up to $25 per acre-ft, and $50 per acre-ft is considered a moderate cost. In highly developed basins, storage may cost up to $100 per acre-ft. As an example, the distributed reservoir storage of 800,000 acre-ft required in the Merrimack basin by this formula, would cost from twenty to forty million dollars, depending on the previously stated unit costs of cheap to reasonable storage. Where a part of the basin is already wholly or partially controlled by natural lake storage or otherwise, allowance should of course be made for the controlled area.

EFFECTIVE USE OF LEVEES

With respect to the second method of flood control—that of providing river walls or levees—there are certain specific advantages. Such protection is definite up to the crest elevation of the river wall, plus such additional height as can be provided by sandbags or otherwise in a flood fight prior to or during the flood. This protection can be attained for any particular locality in a relatively short time, and is not dependent on completion of a long-range program, as in the case of reservoirs. The protection afforded by levees is, of course, local and limited in scope rather than extensive and general, as is the case with reservoirs. Furthermore, there are no incidental benefits, such as might accrue from reservoirs. In many cases, also, there are limits to the protection afforded by levees, as those of great height require a wide base, for which space may not be available. In general, it will be found that levees or river walls will serve their best use as a supplementary means of flood control for areas of concentrated development, to prevent flood damage where only partial reduction of flood heights can be accomplished by a reservoir program.

The third principal method of flood control is by channel improvement, but this is not capable of general application throughout the river. A sharp change in the slope of a flood profile will indicate a restricted channel capacity at a certain point. Field examination will disclose the possibilities of removing ledges in the channel bottom, of widening the channel, of adding spillway gates through existing dams, or of providing additional span or channel area under or through bridges. Such improvement is, of course, effective only in the backwater area upstream from the improvement. Where a material amount of valley storage is eliminated by the improvement, some small increase in flood height downstream may result.

The fourth method, control by diversion, is rarely possible. The auxiliary channels provided on the Mississippi by the New Madrid floodway for the protection of Cairo, and the Bonnet Carré spillway for the protection of New Orleans, are examples of such treatment. There are no locations on the New England rivers investigated by the Boston office where this method can be employed.

Related to flood control by reservoirs is the incidental reduction in flood height obtainable from lakes and storage reservoirs built or operated primarily for power development. In normal operation, the power com-

panies will have drawn down these reservoirs prior to the flood season, with the result that a large though indefinite amount of storage should be available at that time. Such storage reduction cannot be counted on, however,

REINFORCED-CONCRETE RIVER WALL UNDER CONSTRUCTION AT HAVERHILL, MASS.

where there are controlled spillways which maintain a constant pool level practically irrespective of inflow.

The great value of power-storage reservoirs in flood control is well exemplified by the operation of the Rangeley reservoir system on the Androscoggin, the Deerfield and Somerset reservoirs on the Connecticut, and the developments at Lake Winnepesaukee on the Merrimack, at Moosehead Lake on the Kennebec, at Sebago Lake on the Presumpscot, and on the west branch of the Penobscot River. During the flood of March 1936, peak flood flows were reduced by these developments to such a degree that little or no damage ensued.

In summary, it will usually be found that the best solution for the control of floods in any large river basin will combine a moderate degree of reservoir control with the construction of levees or river walls in areas where flood damage is concentrated, and with a limited amount of channel improvement at critical places.

RESULTS OF STUDIES ON THE SALMON FALLS, PENOBSCOT, AND KENNEBEC RIVERS

All these various methods of flood control have been considered in the investigation conducted by the Boston Office. On the Maine rivers, it was generally found that the extent of flood damage now incurred is not sufficiently large to warrant extensive flood control at this time. The river basins in Maine are not nearly as highly developed as those of the Merrimack and Connecticut rivers.

For example, on the Salmon Falls River, with a drainage area of 340 sq miles, one-third of which is already partially controlled by lake storage, the total flood damage from the rare and severe flood of March 1936 aggregated only $8,000. The capitalization of the very limited annual flood damage (estimated at $1,800) discloses at once that any major flood-control program on this river is unnecessary and unwarranted. Studies were made of two reservoirs, Milton and Berwick, which would have eliminated damages completely, but these would cost in excess of $3,000,000.

Similarly, on the Penobscot River, flood damages to the extent of approximately $400,000 were sustained in the 1936 flood. The Penobscot basin is not yet developed to any great degree (110,000 population on 8,570 sq miles of drainage basin), so that large annual flood damages are not sustained. Our studies indicate that an annual flood damage of approximately $60,000 now occurs. Preliminary studies were made for a reservoir system on the Penobscot with reservoirs at Dwinal, Passadumkeag, Saponac, Olamon, Bradford, Kendus-keag, and Six Miles Falls, which would control approximately 1,091 sq miles, or about 12.8 per cent of the drainage basin, at a cost of over $7,500,000. But such a system would cost far more for operation, maintenance, and fixed charges than the present annual flood damage would warrant. It is to be noted that the Penobscot now enjoys a reasonable degree of flood control due to the extensive natural lake and power storage on its headwaters. Approximately 39 per cent of the drainage basin, or 3,339 sq miles, is now partially controlled by existing storage, affording about 224 acre-ft of storage per square mile of drainage basin. In contrast, corresponding figures for the Merrimack and the Connecticut rivers are 61 and 43 acre-ft of storage per sq mile, respectively. For these reasons, no additional flood control for the Penobscot is considered warranted at present.

On the Kennebec River, having a drainage area of 5,970 sq miles and a population of 140,000, a flood damage aggregating $1,600,000 was sustained in the March 1936 flood. Our studies considered five reservoirs, at Long Falls, Anson, Stark, Moose Pond, and Pittsfield. These reservoirs would cost $16,175,000, about $4,647,000 of which would consist of land and right-of-way costs to be borne by local interests. Here again the annual charges for the huge reservoir system necessary to eliminate the flood damage now incurred would be greatly in excess of the annual flood damage. The Kennebec enjoys a control somewhat similar to the Penobscot; 2,090 sq miles, or 35 per cent of the basin is partially controlled, with 225 sq ft of storage per sq mile of drainage basin in existing lake or power-storage development.

FLOOD CONTROL ON ANDROSCOGGIN AND SACO LIKEWISE UNWARRANTED

The Androscoggin River, with a drainage area of 3,470 sq miles and a population of about 150,000, has a lake and pond area of 143 sq miles, partially controlling 40 per cent of its drainage area. Its existing unit storage is estimated as 213 acre-ft per sq mile of drainage basin, an amount comparable to that for the Penobscot and Kennebec rivers. The peak discharge in the March 1936 flood was 74,000 cu ft per sec at Rumford, Me., and 148,000 cu ft per sec near Auburn, Me.—unit discharges of 35.4 and 45.4 cu ft per sec per sq mile. Damage on the Androscoggin aggregated $4,400,000.

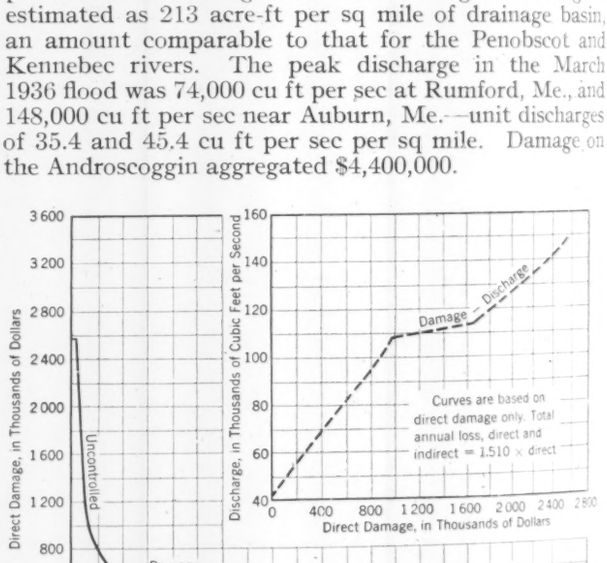

Direct Damage, in Thousands of Dollars
Discharge, in Thousands of Cubic Feet per Second
Uncontrolled
Controlled
Damage – Frequency
Damage – Discharge
Curves are based on direct damage only. Total annual loss, direct and indirect = 1.510 × direct
Average Annual Uncontrolled Loss, $184,300
Average Annual Controlled Loss, $18,000
Number of Floods – 250 Years
Direct Damage, in Thousands of Dollars

FIG. 2. FLOOD DAMAGES, NATURAL AND MODIFIED, AS COMPUTED FOR THE LOWER MANCHESTER REACH OF THE MERRIMACK RIVER
The Controlled Loss-Frequency Curve Is Based on Operation of All Five Reservoirs in the Flood-Control Plan (Combination No. 7 in Fig. 3)

A system of four reservoirs at Rumford, Dixfield, Buckfield, and Oxford was considered, costing a total of $17,795,000, of which local costs of land damages and rights of way would total $8,457,000. For a flood such as that of March 1936, this system would reduce flood heights 4.6 ft at Rumford, 2.5 ft at Livermore Falls, 5 ft at Lewiston, 15.2 ft at Auburn, and 2.8 ft at Lisbon Falls. It would practically eliminate the annual flood loss on this river, which aggregates $453,500.

At one of these reservoirs (the Rumford) supplemental power-storage development could be provided, combined with the flood-control reservoir, by an enlarged reservoir providing 297,500 acre-ft of conservation storage in addition to the 295,000 acre-ft of flood-control storage, at an additional cost of about $4,400,000. Additional power of 108,000,000 kwhr could be provided annually at the downstream developments at a cost of 3 mills per kwhr, if and when flood control warrants the $11,162,000 expenditure required for the flood-control reservoir at this site, and if there is need for additional power at that time.

Our analyses indicate that for the four-reservoir system, annual benefits of $374,100 would result from $1,000,000 in annual costs. The Rumford Reservoir alone, costing $626,000 annually, would net flood-control benefits of $322,700 annually and comes nearest to approaching economic feasibility. None of these reservoirs, however, is warranted at the present time.

It would appear desirable for the state of Maine to acquire or control further developments in the reservoir areas under consideration, so that when future development on the Androscoggin, with resulting increased flood damage, warrants flood control, it can be secured by construction of the reservoir system described.

The Saco River, with its drainage area of 1,730 sq miles and population of almost 145,000, has at present a lake and pond area of 43 sq miles, partially controlling about 50 per cent of the drainage area. Its peak discharge during the 1936 flood was 53,800 cu ft per sec at West Buxton, Me.—a unit discharge of 34.2 cu ft per sec per sq mile. Damage aggregating $1,600,000 was sustained during this flood.

Our studies showed as most favorable a system of two reservoirs, the Fryeburg and Ossipee, controlling respectively 744 and 330 sq miles of drainage area. This reservoir system would cost $7,146,000, half of which would have to be borne by the local interests for land damages and right-of-way costs. The annual costs, aggregating $410,000, would be greatly in excess of the present annual flood loss, estimated at $102,000. This reservoir system would effect a reduction in 1936 flood heights of 12.4 ft at Cornish, from 4.6 to 4.8 ft at West Buxton, and from 4.4 to 6.3 ft at Biddeford.

For the Fryeburg Reservoir, consideration was given to a combined flood-control and power-storage development. With power development at the site, secured at an increased cost of about $3,600,000, 21,000,000 kwhr could be obtained annually at the site, plus an additional 44,000,000 kwhr for downstream developments, at a cost of 4.2 mills per kwhr. If the additional power storage were operated solely for the benefit of downstream developments, without any development at the site, 87,000,000 kwhr could be developed annually at a cost of 2.6 mills per kwhr. If and when flood control is provided for the Saco, and if additional power is required, a combined power-storage and flood-control development, rather than a flood-control reservoir alone, should be built at Fryeburg. However, as previously indicated, there is no economic justification for the provision of flood control on the Saco at this time.

The Merrimack River basin, with a drainage area of 5,015 sq miles, is extensively developed, containing a population of 810,915. The basin sustained a very heavy flood loss during the March 1936 flood, with a direct

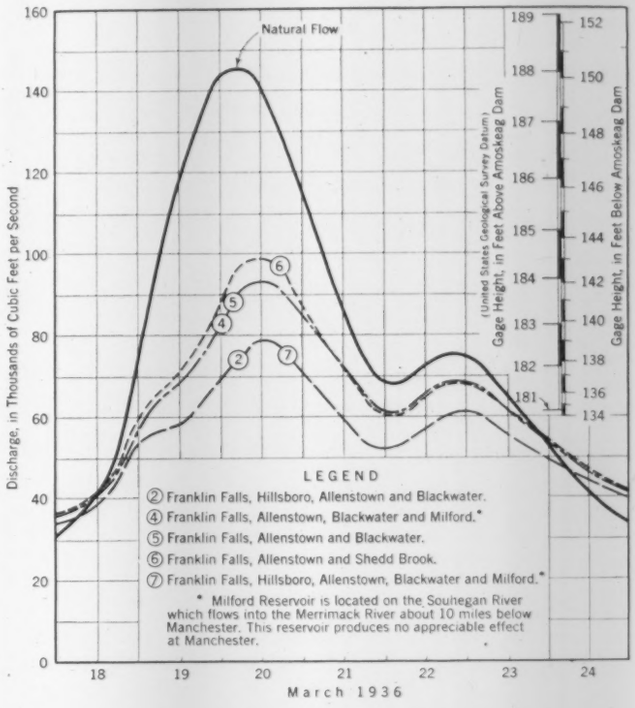

Natural Flow
Discharge, in Thousands of Cubic Feet per Second
(United States Geological Survey Datum)
Gage Height, in Feet Above Amoskeag Dam
Gage Height, in Feet Below Amoskeag Dam
March 1936
LEGEND
② Franklin Falls, Hillsboro, Allenstown and Blackwater.
④ Franklin Falls, Allenstown, Blackwater and Milford.*
⑤ Franklin Falls, Allenstown and Blackwater.
⑥ Franklin Falls, Allenstown and Shedd Brook.
⑦ Franklin Falls, Hillsboro, Allenstown, Blackwater and Milford.*
* Milford Reservoir is located on the Souhegan River which flows into the Merrimack River about 10 miles below Manchester. This reservoir produces no appreciable effect at Manchester.

FIG. 3. EFFECT OF VARIOUS RESERVOIR COMBINATIONS ON THE HYDROGRAPH OF MARCH 1936 AT MANCHESTER, N.H.

damage of $20,147,000, and an indirect damage aggregating $14,257,000.

Our studies indicate an annual flood loss of $1,152,000. A peak discharge of 174,000 cu ft per sec was recorded for the 1936 flood at Lawrence, Mass.—a unit discharge of 37.2 cu ft per sec per sq mile on the 4,672 sq miles of drainage basin above it. Of the 60-odd flood-control reservoirs considered in the preliminary studies, a group of five has been selected which will effect major control of floods in the basin, with resulting benefits greater than annual costs. At Franklin Falls, a reservoir controlling 1,000 sq miles of drainage area, with 170,000 acre-ft of storage capacity, equivalent to 3.2 in. of runoff over the area, can be built at an estimated cost of $7,720,000. A reservoir on the Blackwater, controlling 125 sq miles, with 6.9 in. of runoff capacity, would cost $960,000. A reservoir could be constructed at Allenstown, controlling 246 sq miles of drainage area, with 5.6 in. of runoff capacity at a cost of $3,490,000. At Milford 165 sq miles of drainage area can be controlled by a reservoir with 4.8 in. of runoff capacity, at a cost of $2,185,000. A reservoir controlling 351 sq miles of drainage area above Hillsboro, with 6.6 in. of runoff capacity over that area, can be built at a cost of $5,556,000.

The total five-reservoir system would cost $19,911,000 and would control 1,887 sq miles, or 39.3 per cent of the drainage basin above Haverhill. It would prevent over 80 per cent of the annual flood loss now sustained. As shown in Fig. 3, this system would reduce flood heights for the March 1936 flood at Manchester 5.3 and 11.4 ft above and below the dam, respectively. At Lowell, reductions of 7.4 to 6.1 ft, and at Lawrence, of 3.4 to 6.9 ft, respectively above and below the dams, would be attained. At Haverhill, the 1936 flood height would have

been reduced 5.8 ft. The annual cost of $981,900, including all fixed charges and operation and maintenance costs, would compare with annual benefits from flood control alone of $943,000. Additional benefits to downstream power installations, sanitation, water supplies, and recrea-

CHANNEL IMPROVEMENT IS UNDER WAY AT FITCHBURG, MASS.
View Looking Upstream Showing Bemis Dam and Bridge

tion are more than sufficient to bring the total benefits well above the costs.

The cheapest and most effective developments in this system are the Franklin Falls and Blackwater reservoirs. These two, with annual costs of $421,000, including all charges, would effect flood-control benefits of $695,000 annually.

Consideration has been given to the provision of supplemental power storage at each site. In only one case, at Blackwater, did combined storage seem feasible. At an increased cost of $1,900,000, the Blackwater dam can be enlarged to contain approximately 15 in. of runoff (8.1 in. above flood requirements), by an installation of 10,000 hp. Under these conditions 17,700,000 kwhr can be developed annually at the Blackwater dam; and 7,100,000 kwhr at downstream developments, or, with reconstruction of the Penacook development, 11,400,000 kwhr.

SUPPLEMENTAL OPERATION OF MERRIMACK RESERVOIRS FOR CONSERVATION OF HIGH-WATER FLOW

A plan has been prepared for operating the flood-control reservoirs for conservation purposes outside of the normal flood season. This plan is based on storing a part of the normal high flows occurring after April 15, permitting 5 per cent of the storage capacity to be built up by April 30. Beginning May 1, excess flow may be stored to an upper limit of 50 per cent. The reservoirs would have to be emptied again by March 1. Flood-frequency studies indicate that this method of operation will still allow adequate flood-control storage (even though reduced) during the off-flood season to take care of the 100-year flood which may be expected to occur each month throughout the year. By this method, the normal low-water flow can be augmented, as indicated in Table I, by release of the stored waters during the low-water period.

The value of this increased low-water flow to power development has been evaluated by crediting the existing power installations downstream at 5 mills per kwhr for increased prime power produced during the low-water season. The benefits to such items as sanitation and water supply have been evaluated by a credit of $333 per cu ft per sec for increased low-water flow. This value was determined by a comparison between the increased discharge necessary for sewage dilution (4 to 6 cu ft per sec per 1,000 persons) as contrasted with the annual costs of a sewage-treatment plant (approximately $1,665 for a plant of the capacity for the sewage of 1,000 persons). The large supplemental benefits procurable in addition to flood control are evident.

As previously stated, an interstate compact has been passed by the states of Massachusetts and New Hampshire, providing for the acquisition of the necessary lands for the first two of these reservoirs, Franklin Falls and Blackwater. Surveys, preliminary foundation investigations, and general plans have been completed by the Boston Office for all the Merrimack reservoirs. In the case of Franklin Falls and Blackwater, the detailed foundation investigations have been completed. Plans and specifications are nearly completed and will be advertised as soon as authority to proceed is received.

TABLE I. INCIDENTAL BENEFITS AVAILABLE THROUGH INCREASED LOW-WATER FLOW IN THE MERRIMACK

Reservoir	Increased Low-Water Flow Cu Ft per Sec	Annual Value		Total		
		Power	Sanitation	Flood Control, Power, and Sanitation Benefits	Annual Costs, Incl. Interest, Depree., Maint. & Oper'n	Ratio of Benefits to Costs
F Franklin	414	$71,000	$138,000	$790,700	$371,400	2.13
B Blackwater	63	10,300	21,000	146,300	49,600	2.95
A Allenstown	90	15,000	30,000	202,200	175,300	1.15
M Milford	70	4,425	23,000	101,625	109,200	0.93
H Hillsboro	134	35,350	45,000	427,450	276,400	1.55
	771					
Reservoir System						
BF				$ 935,500	$421,000	2.22
BFA				1,033,500	596,300	1.73
BFHAM				1,325,375	981,900	1.35

THREE LOCAL WORK-RELIEF PROJECTS ARE ALREADY UNDER WAY

In addition to the prospective reservoir program described, work is currently under way on the Merrimack basin at Fitchburg, Lowell, and Haverhill, Mass., under allotments made from the Emergency Relief Appropriation for flood control, using relief labor.

At Fitchburg, a major deepening and enlarging of the channel is under way, including reconstruction of a number of the bridges, removal of certain dams and structures, and provision of levees and river walls.

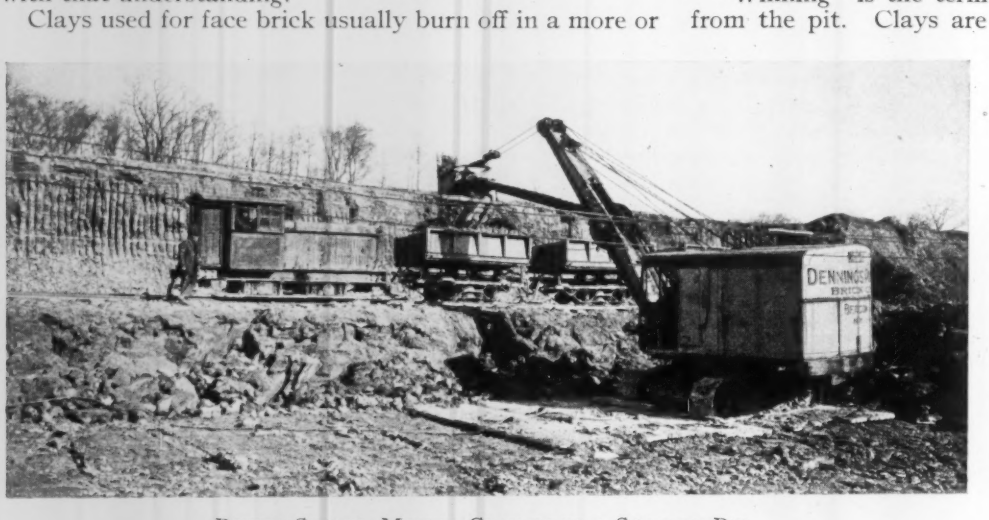
At Lowell, rock excavation is being undertaken in the vicinity of the School Street Bridge, immediately below the Pawtucket Dam. This work includes strengthening of the bridge-pier foundations by reinforced-concrete shells, and removing other constricting rock and gravel areas in the city and at Hunts Falls at its lower end.

At Haverhill, Mass., a reinforced-concrete river wall, protecting the central business section of the city from flood, is being constructed to El. 24, mean sea level, and provision has been made for raising it an additional 2 ft during floods.

The reservoir flood-control plan outlined herein would give a major degree of flood control to the important Merrimack basin, which sustained such serious losses in the spring of 1936. It is hoped that the work will be undertaken promptly, proving, among other things, that states can cooperate by interstate compact among themselves and with the federal government in providing river-basin control of disastrous floods.

in most cases. These clays are easily and cheaply won, mold easily, and burn hard at comparatively low temperatures with a minimum loss from warping and cracking. Sometimes they are tempered by the addition of some other material such as sand or a sandy clay. Common clays vary widely, both in chemical composition and in physical characteristics which affect both color and physical properties of the finished product, so that color cannot be taken as an indication of quality. The purchaser cannot expect to get uniformity of color in the low-price field, and if any particular color or special uniformity of color is wanted, the product should be bought with that understanding.

Clays used for face brick usually burn off in a more or less uniform color such as red, white, or buff, and produce finished ware of a much higher grade than the ordinary common brick (of course at a much higher price, depending upon the degree of perfection desired). Face brick should be free from warping, cracking, and splitting, and should have a fairly low absorption to withstand weathering, but not so low as to become a disadvantage when setting the bricks in mortar.



POWER SHOVEL MINING CLAY FROM A SURFACE PIT

CHARACTERISTICS OF PRINCIPAL PROCESSES

The accompanying chart (Fig. 1) illustrates the flow of clay from the pit to the finished ware in the three most common methods of manufacture in use today. These are the stiff-mud, the soft-mud, and the dry-press processes.

The fundamental principles of preparing the clay are the same in all three processes, which differ only in details and in degree of refinement, depending to some extent upon the type of finished ware required. The stiff-mud process is used where the clay contains just sufficient moisture and plasticity to be extruded through a die. This is the most common method of manufacture, and here the freshly molded, or "green" ware will support considerable weight. All structural clay tile and a great deal of brick are made by the stiff-mud process. The soft-mud process, on the other hand, is used where the clay is too wet to be forced through a die without drying and hence must be molded. The resulting shapes will not support weight. Many millions of brick are made annually in the Hudson River valley and in New England by the wet process, where the clay is usually wet in its natural state. A third method of manufacture is the dry-press process, where the clay in a nearly dry state is molded into desired shapes under high pressure. This process of manufacture makes possible the use of non-plastic materials.

Processes of manufacture of structural clay products may be divided into the following steps:

Selection and "winning" of suitable clay
Storage
Preparation of clay (cleaning, removing large stones and pebbles, grinding, and screening)
Mixing and tempering to produce plasticity, uniformity, and homogeneity
Shaping into units by extruding machines and cutters, molds, presses, or other appliances
Drying, either by natural or artificial means
Burning, usually in kilns

"Winning" is the term applied to obtaining the clay from the pit. Clays are mostly reclaimed by surface-digging or quarrying, and to some extent by mining, depending upon the nature and location of the deposit. In shallow banks a machine called the shale planer is sometimes used, but frequently the clay (and particularly shale) is so solidified that it cannot be obtained except by blasting. In some pits the quarrying method is used, the deposits being worked in benches much the same as is done in stone quarries. Fire clay used for the manufacture of such high-grade materials as glazed ware and face brick frequently has to be mined from some distance below the surface.

The development of the clay pit is a very important matter, requiring careful planning which takes into consideration not only the best methods of getting the clay, but drainage, transportation, and conservation of materials. After the clay has been won from nature, it is usually stored in large piles or bins until required in the factory. Exposure to the air improves the workability of many clays and helps in their preparation. But in many plants, particularly in those using the soft-mud process, the clay is delivered from the pit direct to the preparation plant, or even direct to the pug mill.

The preparation of clays is much the same in all three processes. Some clays require considerable preparation, others very little. The operations to be described here are typical, however.

As the clay comes from the pit or storage bins in cars or belt conveyers, it is usually delivered to a machine called the granulator, consisting essentially of a semi-cylindrical tank within which revolves a steel shaft equipped with knives which are pitched so that they not only break up large chunks of clay and mix and granulate the material, but also function as a screw conveyer, discharging the clay at the end of the machine ready for the next step. (If the clay contains large stones, it is sometimes put through conical rolls which tend to crush small chunks of clay and throw out the stones.) In any case the clay is now ready to be ground if necessary. This may be done in any one of several types of grinders. In some plants the "dry" or the "wet" pan is used. In this operation, grinding wheels called "mullers," weighing four or five tons each, revolve, crushing and mixing the material. In plants where high-grade ware is made, the clay may be screened (if necessary) on fine vibrating screens. In such plants, also, the clay is sometimes heat-treated by passing it through a rotary furnace at about 200 F.

The Manufacture of Structural Clay Products

Outlining the Processes of an Important Branch of Ceramic Art and Science

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CLAY products not only occupy a prominent place among building materials at present, but have maintained such a position since before the dawn of recorded history, as indicated by excavations in Egypt and ancient Chaldea. In addition to common and face brick, the principal burned-clay materials used for structural purposes today are glazed and unglazed tile and architectural terra cotta. In view of the wide application of such materials, a general acquaintance with the various processes of their manufacture is of particular interest to the engineer. The accompanying article gives an instructive bird's-eye view of this major industry, from the pit to the finished product.

As shown by U. S. Bureau of Census reports, the manufacture of structural clay products including common and face brick, structural clay tile, and architectural terra cotta, is one of the major industries of this country. In 1935 it employed about 45,000 persons, exclusive of salaried officers, clerks, and miscellaneous employees, in nearly 1,100 establishments. The total factory cost of structural clay products manufactured in 1935, exclusive of overhead, was over $110,000,000. In 1929 it was nearly $300,000,000. In 1935 there were produced in the United States over 1,800,000 thousands of common brick, 600,000 thousands of face brick, and about 900,000 tons of structural clay tile. These figures do not include ceramic floor and wall tiles, roofing tile, drain tile, sewer pipe, paving brick, conduit, and many other non-structural materials made from burned clay.

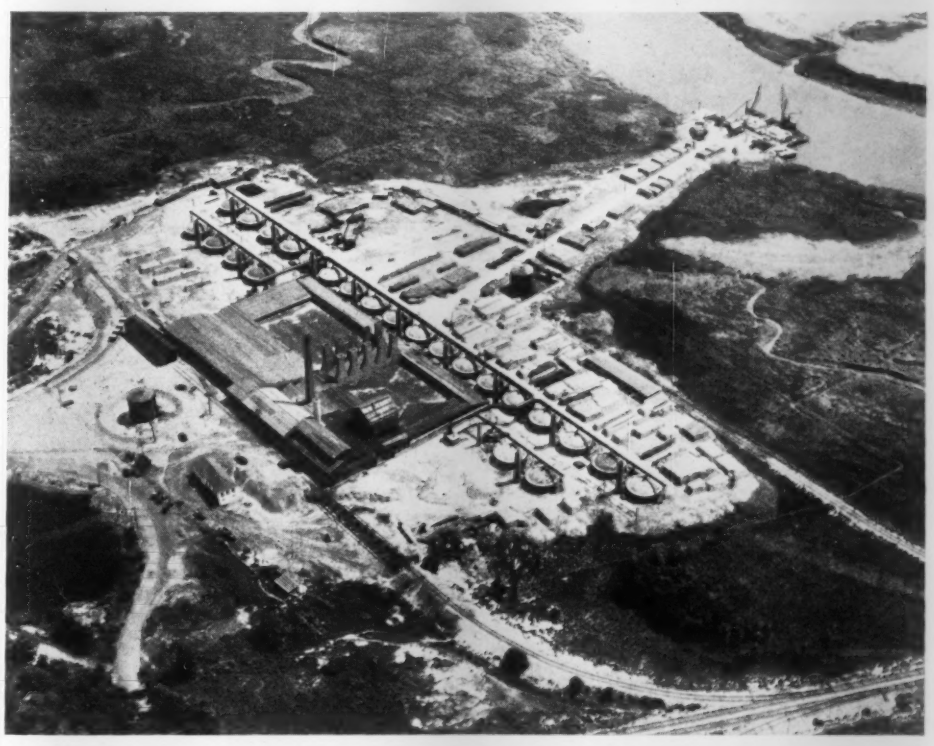
Clay is a tricky and temperamental material to process, as deposits may differ widely in chemical composition and physical characteristics. However, by the use of modern scientific methods the ceramic engineer can make of these widely varying raw materials surprisingly uniform products of various types for many different uses.

Ancient peoples made many excellent clay products by laborious methods, which were little improved for many centuries, but during the past fifty years there has been a great development in clay-working machinery, until now we have plants capable of turning out millions of tons of structural clay products annually. The chemical and physical characteristics of various types of clay are carefully analyzed in laboratories, and the best methods of handling and processing are carefully determined before the plant is designed.

The clay to be used must develop the proper plasticity and be capable of drying rapidly without excessive shrinkage, warpage, or cracking. It must be capable of being burned to the desired texture and strength specified. If a clay contains too high a percentage of such impurities as iron, or lime, magnesium, or other alkali, either the clay must be rejected or the impurities removed or neutralized. Withal, the final cost of the finished products must be kept in mind, as clay-products manufacture is a highly competitive field.

In the manufacture of structural clay products the materials most commonly used are fire clay, semi-fire clay, surface clay, and shale. Fire clay has a fusing point as high as 3,200 F, and its fluxing impurities—such as ferric oxides, lime, magnesium, and alkali, are small. Semi-fire clay fluxes at a lower temperature than fire-clay; its impurities are likely to be greater; and it is harder to control in the process of manufacture. Semi-fire clay is found near the surface in abundant quantities in certain locations, notably in New Jersey. Clay shales are found in large quantities in many districts, and many of them produce excellent burned-clay products. They are not usually soluble in water except when ground up, those suitable for the production of clay products then becoming plastic with addition of moisture.

Low-grade clays and shales are extensively used in the making of common brick of medium grade, which is red



A Modern Plant Manufacturing Hollow Tile, Brick, and Other Structural Clay Products.
This Plant Utilizes Round Periodic Down-Draft Kilns with a Waste-Heat Collecting System. The Square Stacks Provide Draft for the Dryers

After the clay has gone through all the preliminary steps of preparation, it is ready for tempering, the object of which is to bring the clays into a homogeneous plastic mass ready to be molded into units of proper shape. Clay is sometimes tempered by running it through rolls, but more generally this is accomplished by the use of pug mills. A pug mill consists essentially of a chamber within which revolve one or two shafts with blades rigidly attached, which thoroughly mix the material. Water is added if needed to produce the desired plasticity.

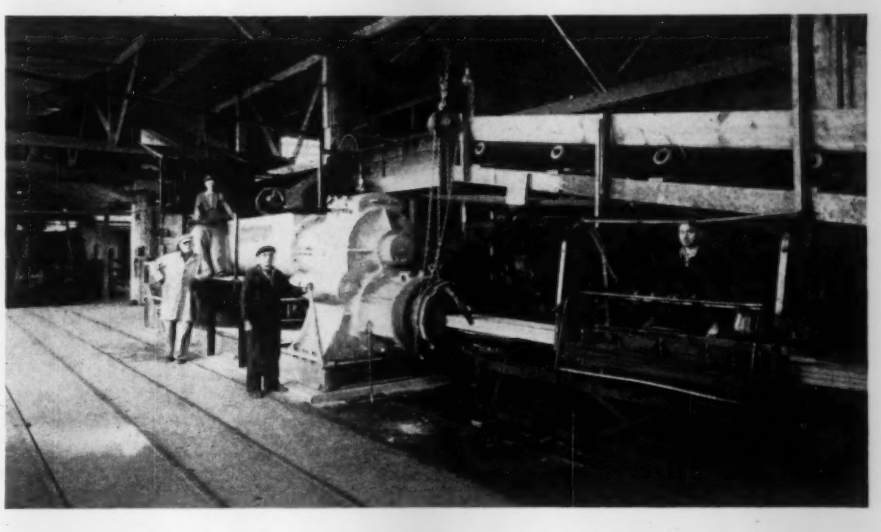
FORMING AND MOLDING

In forming the clay into the desired unit shapes, the stiff-mud and soft-mud processes employ different means. In the stiff-mud process of forming and molding, the clay is delivered to an auger machine which forces the plastic mass out through a molding die in a continuous stream called a "column." The die molds the mass into the desired shapes for brick, hollow tile, or other forms, and as the column is extruded it passes through a machine which cuts it into the desired lengths. In the size of the die and in cutting to length allowance is made for the shrinkage that will result from drying and burning. After the units are cut to length they pass to a take-off belt for inspection. The perfect units are taken off by hand and sent to the dryer, while the imperfect ones are returned to the pug mill for retempering.

Auger-machine dies have to be carefully made to suit different types of clay. All dies must be lubricated by oil, water, or steam, as few clay columns will run through freely without having their corners pulled back or being otherwise damaged. Lubrication also helps cut down on power consumption. Special dies are made to form the hollow cells of structural clay tile and similar shapes. Brick is extruded either toward the side or the end, producing "side-cut" and "end-cut" bricks, respectively. Structural clay tile, drain tile, and similar shapes are all end-cut.

De-airing is a very recent and important development in the stiff-mud process. It is accomplished by use of a de-airing chamber attached to the auger machine, through which the clay passes. The clay is broken up and shredded as it enters this chamber, where a vacuum of from 15 to 29 in. is maintained. Some of the chief advantages of de-airing are greater strength in the green and in the fired body, increased workability and plasticity, and better utilization of inferior clays. In spite of these and other advantages, however, there are a few clays which do not respond favorably to the de-airing process and in such cases it cannot be used.

In the soft-mud process, all clay ware is today molded



The Stiff-Mud Process of Clay Products Manufacture
The Machine at the Left, Comprising Pug Mill, De-Airing Chamber, Auger, and Die, Is Extruding a Column of Clay Onto the Table. A Cutting Machine Appears at the Right

by machinery, except for some special products. In large modern plants, brick are molded under pressure in a soft-mud brick machine which tempers the clay in its pugging chamber, sands the molds, presses the clay into from 4 to 9 molds at a time, strikes off the excess clay, bumps the molds uniformly, and dumps the brick onto a pallet with each revolution. The pallets of brick are carried away to the dryer as fast as made. The operation of the machine is entirely automatic, and the only hand labor used is that required to feed pallets and sand into the machine. This machine is illustrated in one of the photographs. There are two classes of soft-mud brick—sand-struck and water-struck. In manufacturing the first kind, the inside of each mold is coated with a thin layer of sand to prevent the clay from sticking. In the second method, also sometimes called slop-molding, the molds are dipped in water to prevent sticking. Sand-molding is the most common method, but some very fine grades of brick are water-struck, particularly in the New England states.

The dry-press method permits the use of more or less non-plastic and relatively dry clays in the manufacture of high-grade ware. The best results are obtained when the material contains from 7 to 10 per cent moisture. The clay is usually prepared by disintegrator, granulator, grinder, and pug mill, and then put into molds and subjected to pressures of from 550 to 1,500 lb per sq in. Dry-press brick machines are operated automatically or semi-automatically, and turn out from 20,000 to 30,000 brick per day. After the units have been molded, the ware is dried and burned in the same manner as in the stiff-mud and soft-mud processes.

As wet clay units come from the molding or extruding and cutting machines, they contain from about 7 to 30

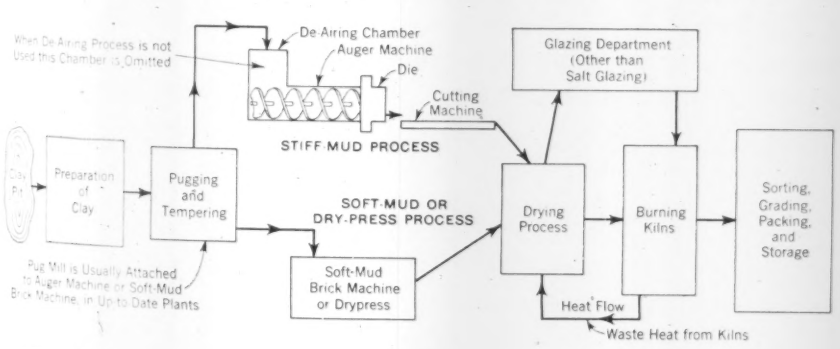
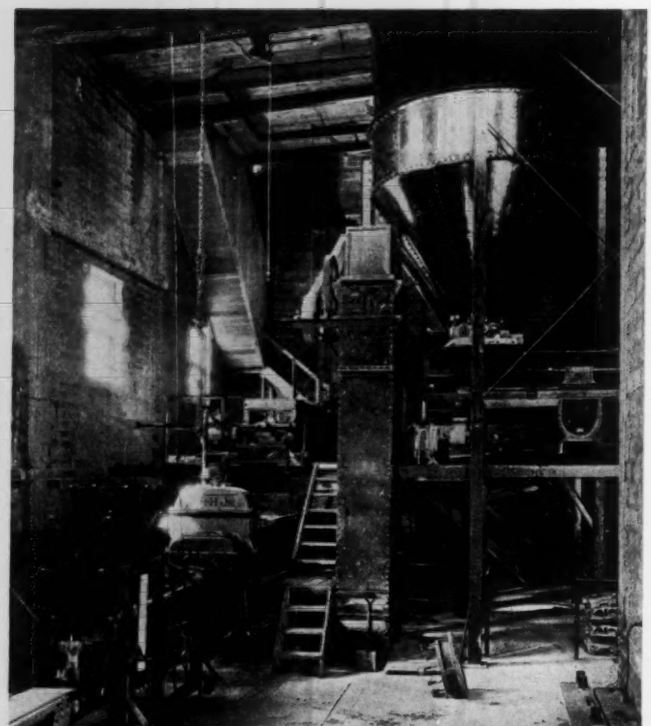

When De-Airing Process is not Used this Chamber is Omitted
De-Airing Chamber
Auger Machine
Die
Cutting Machine
Glazing Department (Other than Salt Glazing)
STIFF-MUD PROCESS
Clay Pit
Preparation of Clay
Pugging and Tempering
SOFT-MUD OR DRY-PRESS PROCESS
Drying Process
Burning Kilns
Sorting, Grading, Packing, and Storage
Pug Mill is Usually Attached to Auger Machine or Soft-Mud Brick Machine, in Up-to-Date Plants
Soft-Mud Brick Machine or Drypress
Heat Flow
Waste Heat from Kilns

Fig. 1. Flow Chart Showing Typical Operations in a Modern Plant for Manufacturing Structural Clay Products



MACHINERY ROOM OF A STIFF-MUD CLAY PRODUCTS PLANT
Showing, from Right to Left, Storage Bin, Feeder, Granulator, Pug Mill, Auger Machine, and Automatic Cutting Machine

per cent moisture, depending on whether the dry-press, stiff-mud, or soft-mud method has been used. Most of this moisture is removed in dryers by evaporation before the burning process begins. Moisture occurs in clay ware in three forms: Free water which fills the pore spaces; water which clings to the pore walls after the free water is removed; and hygroscopic, colloidal, and chemically combined water. The removal of most of the moisture in the first two forms is accomplished in the drying process, and the remainder is removed during the first stages of burning.

DRYING AND BURNING OPERATIONS

Drying is a process requiring scientific supervision. In recent years mechanical driers have come into almost universal use, which permit of automatic control of temperature, humidity, air velocity, and other factors which differ with the type of clay and ware produced. As the free water of the clay body is removed, the clay particles tend to coalesce, causing shrinkage. But this process must not be carried on too rapidly or the surface will dry and harden before the interior, and cracking will occur. The average time necessary for drying structural clay products is about three days, and the temperature required is from 100 to 300 F.

There are many different types of artificial driers, but in each the primary object is to remove the moisture from the ware in the shortest possible time, and at the lowest cost consistent with the problem at hand. The heat may be supplied directly or may be waste heat recovered from the kilns. In all cases the heat and humidity of air in the drier tunnels must be regulated so as to avoid spoiling the ware.

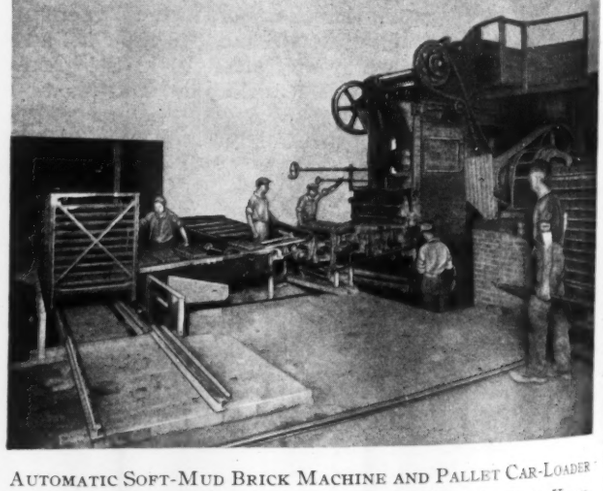
In the humidity system of drying, which is sometimes used, the wet ware is placed in a closed room. Highly humidified warm air is admitted to the room and the ware is heated up until the vapor pressures of air and clay are about equal. When this point has been reached, the relative humidity of the air surrounding the clay body is decreased by raising the air temperature. This sets up a difference in vapor pressure which draws moisture from the ware, and the action continues until practically all the free moisture has been removed.

Burning is one of the most specialized processes in clay-products manufacture, and requires an average time of from 60 to 100 hours. It is done in one of several kinds of kilns, which may utilize wood, coal, natural or artificial gas, or oil. Sometimes electricity is used for burning light special ware.

The different stages of burning may be referred to as water smoking, dehydration, oxidation, vitrification, flashing, and cooling. The ware is stacked in kilns in such a way that the hot gases can flow freely around or through the entire mass, and the temperature of each piece can be raised gradually and uniformly. Water-smoking then begins and lasts for from 10 to 12 hours or more. During this period all free water left in the ware is driven off, under temperatures of from 250 to 350 F. As the kiln may contain several hundred tons of ware having from 1 to 2 per cent moisture content, there may be several tons of water to be driven off. This gives some indication of the amount of thermal energy required for water-smoking.

After water-smoking has been completed, the kiln temperature is gradually raised to dehydration temperatures, which start at about 800 F and rise to from 1,200 to 1,400 F when dehydration is complete. During this period the chemically combined water is driven off by breaking down the clay molecules. Oxidation also begins during the dehydration period, taking place at temperatures ranging from about 500 F to 1,200 or 1,400 F. During this period all combustible matter is consumed, sulfur from pyrites and carbon dioxide is expelled, and any ferrous iron is oxidized to the ferric condition. Oxidation requires an even temperature for a time and plenty of air introduced. This stage of the burning process must be carried out slowly and carefully, since the clay then has low mechanical strength, but after its completion burning can proceed more rapidly.

Vitrification is the contracting and filling-up of the pore spaces of the clay. Structural clay products are usually burned to the incipient stage (at temperatures of from



AUTOMATIC SOFT-MUD BRICK MACHINE AND PALLET CAR-LOADER
This Machine Will Produce up to 100,000 Brick in Eight Hours

1,600 to 2,100 F, approximately), when the clay has been softened to a point where the larger grains stick together, but all the pores of the mass are not closed. A clay product is said to be completely vitrified when this process is complete, the mass has been rendered impervious, and maximum shrinkage has taken place. Paving brick, vitrified sewer pipe, and conduits are burned to practically complete vitrification. Flashing, done by reducing the fire near the end of a burn, produces certain desired colors and shades of colors, varying with different types of clay. This process requires skill and experience with each particular clay. Cooling is not strictly a stage in burning, but is nevertheless important in finishing certain classes of clay. From 48 to 72 hours are required for proper cooling. The rate of cooling has a direct effect on the color, and too rapid cooling may cause cracking and checking in glazed surfaces.

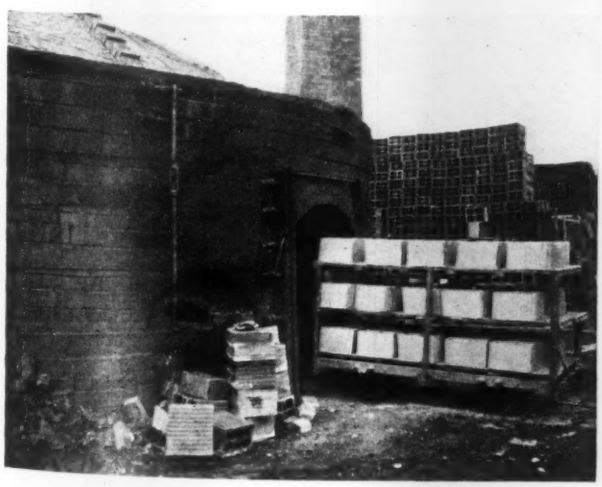
MANY VARIETIES OF KILNS ARE USED

A kiln is a furnace consisting of a chamber or series of chambers in which materials are fired or burned. Kilns may be round or rectangular, up-draft or down-draft, periodic or continuous. The chief types in general use for firing structural clay products are scove, muffle, continuous, periodic up-draft, periodic down-draft, and tunnel kilns.

Scove kilns, which belong to the up-draft group, typify an old but very efficient method of burning common brick. Dried green brick are stacked up to form an arch. When the fire is introduced, the hot gases travel upward around and between the brick. As many arches as desired can be built side by side. The outside is encased with brick, usually soft-burned from a previous burn, and then dubbed up with mud to prevent leakage. Scove kilns have capacities of as much as one to two million brick at a burn, but are not suitable for burning high-grade ware that requires accurate control of heating and cooling.

The term "muffle" is applied to any kiln equipped with a muffle which prevents the flame from coming in direct contact with the ware. A continuous kiln has a succession of chambers connected by flues or tunnels in such a way that the hot gases flow through from one chamber to the next. The continuous kiln makes use of a large amount of heat which is wasted in ordinary kilns.

A periodic kiln is one that is loaded, fired, allowed to cool, and unloaded before reloading. The terms "up-draft" and "down-draft" are self-explanatory. The up-draft kiln is not much used for structural clay products. Periodic down-draft kilns are commonly used in burning structural clay tile of all types, face brick, and glazed ware—in fact, any product requiring close control of heat. The ware is stacked in such a way that the hot gases travel up within "bag" walls, built inside the kiln walls, to the crown of the kiln, and are then pulled down through the ware to flues under the floor and thence to the stack or the driers, if the waste heat is used for that purpose.



A KILN FOR BURNING STRUCTURAL CLAY TILE
Showing a Dryer Car Carrying a Load Into the Kiln

EXIT END OF A CONTINUOUS TUNNEL KILN, SHOWING A CARLOAD OF FINISHED BURNED WARE

The tunnel kiln, a very recent development, is built both as a straight and as a circular tunnel, through which the ware passes while being burned. The ware is loaded on special cars, which then enter the tunnel and travel at the correct speed through the water-smoking, dehydration, oxidation, vitrifying, and cooling zones. The heat conditions in each zone are carefully controlled. Some of the most modern tunnel kilns, costing from $80,000 to $100,000 to install, are capable of burning 80,000 to 100,000 brick per day. Some of the advantages claimed are that there is less loss of heat, and also that the product can be more uniformly burned.

Several kinds of glazing are in general use, the most common being salt-glazing. Salt-glazing, a very old process, is done by introducing common salt into the fire box near the end of the burn when the ware is approaching incipient vitrification. A salt glaze is a glass coating formed on the surface of the ware. The vapors from the salt are carried into the kiln, where the sodium comes into contact with the surfaces of the ware and combines with the silica and alumina of the clay body to form a coating. In order to get a uniform glaze, the flow of gases and salt vapor must be carefully controlled by dampers.

Spray-glazing consists of spraying the glazing materials over the ware after drying and before burning. As the ware is brought from the drier, it is passed through a heating tunnel on a conveyor, in order to bring it up to a uniform temperature, which must be maintained while the glaze is being applied by spray guns. The ware is afterward taken to the kilns for setting and firing. Spray glazes are compounded of a variable number of mineral ingredients in such proportions that at a given temperature they will fuse together in a glass-like coating. Some of these mineral ingredients are feldspar, flint, zinc oxide, lead oxide, calcium carbonate, barium carbonate, and borax. Coloring agents may be added, producing almost any color desired.

Other types of glazing which may be mentioned are slip glazing and fritted glazing. Some clay products are burned before they are glazed and again after the glaze has been applied. This process melts the glazing materials and establishes a union between the glaze and the body.

Geology and Civil Engineering

In Certain Cases Cooperation Is Called for Between These Two Fields

By WILLIAM OTIS HOTCHKISS, M. AM. SOC. C.E.
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AS modern structures continue to increase in over-all dimensions, particularly in height, foundation problems are attaining increased importance. Unfortunately, little is known about the strength, elasticity, or compressibility of rocks which contain clay seams or disintegrated parts, as test samples removed from the site indicate only the probable behavior of the strongest elements. Moreover, the three-way stresses of the material in its natural state cannot be duplicated in the laboratory. Dr. Hotchkiss points out the need for a method of making tests on such rocks and on unconsolidated materials without removing the samples. Other instances where the fields of the geologist and the civil engineer overlap are given, together with some basic data on the physical properties of rocks. The accompanying article is abstracted from Dr. Hotchkiss' paper delivered on March 17, 1937, before the Society's Metropolitan Section.

CIVIL engineers are interested in two general classes of materials: Processed materials such as steel and alloys, building stones, cements, timber, and asphalts; and natural materials in place, including solid rock and unconsolidated materials.

A large amount of detailed information is available for the processed materials, so that design can be reasonably accurate. After the design is finished, we apply a proper factor of safety and go ahead. But the available information for natural materials is in comparison very slight, and consequently we hardly think of design as applicable to them. Here we must deal with an infinite number of variables, the limits of which we know but vaguely, so that our mathematical formulas are most unsatisfyingly indefinite.

It is when the engineer deals with natural materials that he needs to know as much as possible of the field of geology. On the other hand, when the geologist is called upon to deal with the natural materials on the limited scale in which they are used in construction activities, he often finds his knowledge too general to be highly effective. So it is only by the cooperative work of men from all related fields of knowledge that we can hope to arrive at a satisfactory understanding of the problems which require solution.

From the civil engineer's viewpoint we can consider the earth's crust to be made of two kinds of materials, solid rock and the mantle of unconsolidated material overlying it. Solid rock is of two general groups: (1) igneous and metamorphic rocks, and (2) the sedimentary rocks. In general, igneous and metamorphic rocks are very strong, crystalline in character, and able to bear any required weight, unless there are faults or unless they are too much broken up.

Sedimentary rocks, on the other hand, vary more widely in strength and character. This is not surprising when we consider that they are the recemented, residual products of the decay of the crystalline rocks, or of older sedimentary rocks. The complete decay of a crystalline rock results in the alteration of most of the minerals except quartz. The largest part becomes clay minerals and the next largest is quartz. A minor percentage, including most of the alkalies and lime, is carried away in solution.

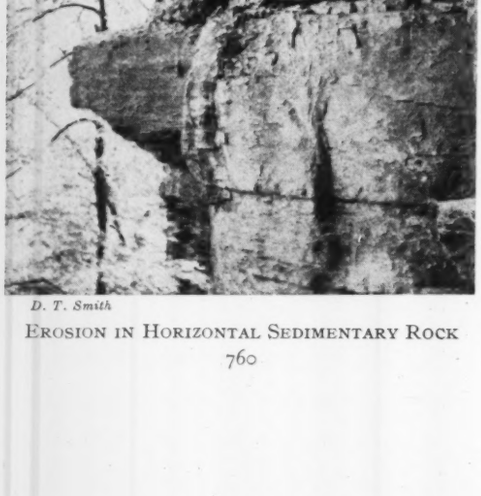
The fine materials are carried to the streams and eventually to the sea, where they are worked over by the waves and assorted in accordance with their size, shape, and weight. Deposits of pure silica sand, pure clay, or pure lime material are rare and relatively small.

INFINITE VARIETY OF ROCKS

To the great bulk of our sediments we give names in accordance with the predominant material in the mixture. Thus, when we speak of sandstone we may have in mind a deposit that contains 99 per cent quartz sand or one that contains less than 40 per cent. When we speak of shale we may think of a material that has only 20 per cent of clay minerals or of one that has 90 per cent. A limestone similarly may vary widely in its content of carbonate mineral.

In addition to this infinite variety of composition, materials possess varying degrees of consolidation. A clean quartz sandstone may vary in character from a thoroughly cemented rock able to bear any weight we may desire to put upon it, to a rock having not much greater strength than loose sand, and so weakly cemented that it can be excavated with a pick and shovel. Finally, the proportion of organic matter deposited with clays and silts may vary from nothing to a sufficient amount to make a mineable coal seam, for example.

Thus far I have been speaking only of what we ordinarily class as "solid rocks" (Cambrian, or Paleozoic, or Tertiary), as they are found deep buried and fresh. When exposed at the surface, these rocks undergo the disintegration of weathering. This is a very slow process, yet crystalline rocks in the Piedmont belt from Maryland to Georgia have been found to be disintegrated and decomposed to depths of as much as a hundred feet. Limestones also have been dissolved so that they are porous or cavernous to depths of many scores or even hundreds of feet. This has often taken place even where limestone beds are well obscured by mantle rock and soil, or by shales or sandstones of insoluble nature, and in such cases the limestone has frequently caused trouble by providing large channels for the



D. T. Smith

EROSION IN HORIZONTAL SEDIMENTARY ROCK

wastage of water stored in reservoirs. In glaciated areas the solid rocks have had their mantle of weathered rock removed by the action of the glaciers, and are seen, with rare exceptions, only in their unweathered state.

ORIGIN OF UNCONSOLIDATED ROCKS

The second broad class of rocks are the unconsolidated materials that overlie the solid rocks—the mantle rocks (including the residual weathered rock in regions south of the glaciated areas), tilled soils, sands, gravels, clays, and organic matter that make up the surface of most of our inhabited areas.

Differing more widely among themselves than the solid rocks, these unconsolidated rocks occur in thicknesses up to 500 or 600 ft, but they are rarely more than 200 ft, and usually not much more than 100 ft thick. Since in the northern part of the United States they are mostly glacial in origin, it is worth while to consider for a moment the work of the great ice sheets and how they deposited their burden.

The front of a glacier is practically always melting, and the load of miscellaneous debris it carries is dumped at that margin. Where streams flow from the ice they pick up part of the material, assort it into gravel, sand, and clay, and deposit it. These deposits change rapidly as they are built up. For example, a thick bed of gravel may pinch out within a few feet horizontally and give way to a fine clay or a sand. Where glacial streams discharge into a lake, the fine material may be uniformly distributed over large areas.

During the advance of the ice sheet, these deposits were overridden and compacted and the water squeezed out by the great pressure of the ice (of the order of 150 tons per sq ft). Thus originated much of our glacial hardpan. As the ice sheet advanced farther, the thickness of the ice over these deposits increased, and the eroding power finally became so great that part or all of the previously deposited materials were picked up and carried on, eventually to be dropped again at a new ice front. When the front of the ice sheet melted back for the last time, the material it dropped was not overridden, but was left as it was deposited, either as a jumble of boulders, sand, gravel and clay, or as more or less well-assorted material. This type of deposit overlies the hardpan remnants of the earlier compacted deposits made during the advance of the ice sheet.

These glacial deposits of various kinds together constitute the mantle rocks that engineers are concerned with in the northern part of the United States. They vary even more widely in character than the sedimentary rocks, from hardpans almost as safe as solid rock, to marls that are almost as unstable as water.

In Illinois, Iowa, Minnesota, and Wisconsin, these latest deposits of the ice sheet are covered in many places, to depths varying from a few inches to a hundred feet or more, by fine-grained, wind-blown material—proof positive that the "Dust Bowl" and its activities date back at least 25,000 years. And, I may add incidentally, this ancient process seems quite likely to continue long after the present population has itself turned to dust.

The physical properties of the rocks discussed are in reality the physical properties of the individual grains and openings of which they are composed. The mineral particles are not perfectiy welded together even in the hardest and most recent igneous rocks, and their orientation is almost always heterogeneous. The amount of voids in rocks may vary from a fraction of one per cent, in the most dense rocks, to 70 per cent or more in the least dense. These voids occur in a great variety of forms; for example, they may be roughly equidimensional like those in sandstone, or they may be thin and tabular in form as in a slate or schist. However, the shape of the voids sometimes has a greater influence on the strength of the rock than their size, since a rock with a small percentage of voids, like a slate, may be weak, while a rock with a large percentage of voids, like a sandstone, may be strong.

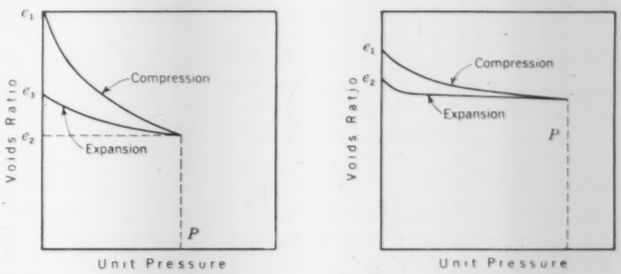


FIG. 1. CHARACTER OF MOVEMENTS IN CLAY AND SAND DUE TO THE APPLICATION AND RELEASE OF LOAD

The engineer is interested in the properties of rigidity, elasticity, crushing strength, shear strength, compressibility, and temperature coefficient. In unconsolidated rocks, he is also interested in the effect of pore-space filling, whether water or air, on these properties. We have satisfactory tests for these properties in the case of solid rock to be used in construction materials. But with regard to both solid and unconsolidated rocks to be used as supporting material, we have much to learn before we can draw satisfactory conclusions from preliminary tests.

In addition to the pore spaces previously mentioned, there are other openings at the surfaces of all solid rocks. The regular open fractures which the geologist calls joints, and which to the quarryman and miner are often known as breaks or fissures, occur with quite uniform spacing and inclination in any limited area. Bedding planes are often more or less open because changes in the sizes or kinds of sediment make them planes of weakness. Faults along which movement has taken place are not uncommon. If these openings are large enough, clay or other fine material may be carried in suspension by rain water and deposited in them, and if conditions are favorable they may be almost completely filled by solid crystalline material deposited from solution.

In unconsolidated rocks with a high percentage of water-filled pore space, such as clays, the pressure of any overlying load tends to squeeze out the water. This process is slower the finer the size of the water-filled spaces, and the farther the water must go to escape. In fact, some very fine clays have maintained a high water content for many millions of years while submitted to deep burial and consequent high pressure.

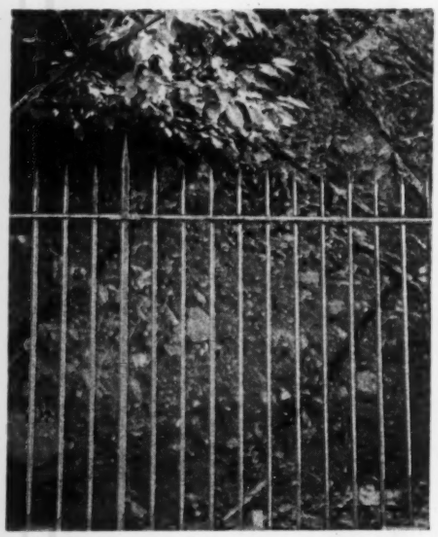
MOVEMENT AND FLOW OF ROCKS

Another important factor in the physical condition of rocks is the movement to which they may have been subjected. These movements are of all degrees of magnitude, from great to minute, and there is evidence to prove that even the strongest rocks have flowed like so much clay under the pressure and other physical conditions at great depths, and that such slow viscous flows have amounted to movements of many miles, both horizontal and vertical.

These great flows indicate that there are limits to the elasticity of even the hardest rocks. However, the movements that concern the engineer more directly are the much smaller ones due to faulting and the even more

minute ones due to change in loading, either natural or artificial, such as those shown diagrammatically in Fig. 1. Such changes in loading may be the result of a body tide which has been observed in the earth and which has been shown by measurements to be of the order of 6 in. per day. Again, the effect of each 10-ft tide on the coast is equivalent to adding and removing a pressure of 625 lb per sq ft.

Even the usual changes in barometric pressure are equivalent in their effect to the load of a foot of water, and such changes add or subtract a load greater than the heaviest rainfall. With an increase in barometric pressure, the amount of air in the openings in rocks is increased. The earth inhales at such times, and when the pressure decreases the earth exhales. There are also movements of inches, both vertically and horizontally, due to changes in the water content of clays. Surface benchmarks may move 6 in. or more in any direction, carried by the expanding or contracting soil in which they are set.



D. T. Smith

FAULT BRECCIA FORMED BY OVERTHRUST

Photographed on the Campus of Rensselaer Polytechnic Institute

Other movements of rock with which the engineer is concerned are vibrations from whatever cause. These may be from earthquakes or from blasting, and some damage to buildings is said to be due to the harmonic vibrations set up by traffic. In view of all these different kinds of flowage and movement, the geologist is compelled to look upon the earth as a "moving, weaving, breathing, progressing thing."

DIFFICULTIES IN STUDYING FOUNDATION CONDITIONS

I believe it is clear from the foregoing why it is unsafe to assume that materials or conditions extend beyond the area that has actually been investigated. I now want to discuss some of the difficulties that confront us in studying the foundation conditions for such heavy structures as dams, bridge piers, and heavy buildings. In looking through the three large volumes of papers and discussions presented at the International Conference on Soil Mechanics and Foundation Engineering, held at Harvard University in 1936, I was impressed strongly with the fact that nearly all the tests made were on samples removed from their original situations and conditions to new and different ones. It was many times brought out forcibly that there is no measure of the alterations that take place during this removal, although much ingenuity has been displayed in the effort to get undisturbed samples.

A core drilled from solid rock is a good sample of the solid material, but when a weak layer such as a clay seam or a disintegrated part of the rock is penetrated, the sample is not at all representative. One is forced to question the value of tests that reflect only the probable behaviors of the strongest part of the total aggregate about which information is needed. Furthermore, the conditions of the tests can only approximate the conditions of the material in its natural state. The material as it is to be used will be subjected to three-dimensional stresses from its natural surroundings as well as to stresses from the new load that is to be superimposed, yet we have no satisfactory method of producing these three-dimensional stresses during the test because we do not know what they are.

Now if there is this difficulty with the relatively easy sampling method of core-drilling in solid rock, what can be expected from tests of samples of unconsolidated materials? The disturbance caused by the tool used to secure the sample always alters the sample in some degree before it is removed from its setting.

Moreover, if this setting is below the water level, the unconsolidated material contains a certain percentage of voids filled, under the pressure there existing, with water which may have in solution either air or other gases, or both. When the sample is removed to the surface, both temperature and pressure are changed, with consequent liberation of gas, or increase in internal pressure if none is liberated. The best tests thus give only an approximation which requires interpretation.

This is not to say that such sampling methods and tests as we now have are useless. On the contrary, they have shown results that have often been satisfactorily checked by later experience. My criticism is directed at their lack of perfection rather with the purpose of emphasizing the need for knowing more than these tests now tell.

We have confined most of our efforts, up to the present, to taking samples from the site to the laboratory. It might be very profitable to direct the thoughts of some of the men carrying on this research to consideration of tests to be applied without removing the test sample. It is from the united efforts of physicists and engineers that the greatest advance in devising such a method is to be expected. Perhaps I should add that the geologist might occupy a modest place as an adviser. Few physicists are interested at present in problems of this nature, and their interest should be aroused.

Perhaps the first interest might be supplied by the geophysicists, who have already done much preliminary work on the problem by developing methods for locating economically valuable deposits of minerals from the surface. They have also done some work in relation to foundation materials, and their attention should be directed to these other important problems that confront the engineer.

The ultimate objective of the engineer in his study of foundation materials was most excellently stated by Charles Terzaghi, M. Am. Soc. C.E., in his presidential address before the International Conference on Soil Mechanics and Foundation Engineering, previously mentioned. In referring to the work of the Society's Committee to Codify Present Practice on the Bearing Value of Soils for Foundations, organized in 1913, he said:

"The outstanding achievement of this committee, with Mr. R. A. Cummings as chairman, consisted in a realization of the importance of expressing the properties of soils by numerical values."

We have made much progress towards this objective in the last few years, but I firmly believe that still greater progress lies before us. Although the variations of materials, including also their sizes and states of aggregation, are infinite in number, I believe it will be possible by scientific methods to secure the accurate information needed by the engineer at a reasonable cost.

Social Horizons of the Engineer

Engineering Aspects of Some Current Economic Problems

By Harry J. Engel

Junior American Society of Civil Engineers, Harrisburg, Pa.

ENGINEERING achievements have so clearly influenced the course of events in the twentieth century, says Mr. Engel, that the engineer should occupy a prominent position in modern society. The necessity for preventing a recurrence of recent disastrous floods and a belief that technical progress has tended to unbalance society have further served to focus attention on the engineer and his activities. A brief survey from the engineer's viewpoint of the three most important factors in the production and distribution of wealth—land, labor, and capital—is therefore believed to be timely. The accompanying paper is abstracted from Mr. Engel's address delivered on May 19, 1937, before the Philadelphia Section, on the occasion of the meeting conducted each year by Juniors.

LAND, labor, and capital are the three most important factors in the production and distribution of wealth, where wealth is regarded realistically as made up of real goods and services. The land is the origin of our wealth; labor is the human effort used in producing and distributing it; and capital embraces those devices which permit labor to be more effective, such as the equipment of factories, railroads, and stores.

As we survey these three wealth factors in order, we find, first, some growing deficiencies in the land. Although the original resources on our continent were unparalleled in history and supported the greatest expansion ever known, they are decidedly waning. The accompanying chart, Fig. 1, drawn from data in *Rich Land, Poor Land*, by Stuart Chase, and from production figures in *The World Almanac*, shows in black the estimated proportions remaining of some of our original reserves, and also indicates at the bottom the amounts used annually.

There is evidently still an abundant supply of coal, particularly bituminous coal, and a moderate supply of iron. But copper, lead, zinc, oil, and timber are critical resources; at 1935 rates of use our 1936 oil supply would last only 13 more years, timber 40 years, and lead 12 years—and the rates of use are in some cases accelerating!

Although our resources are thus decreasing, there is still waste in their production. For instance, illegal "hot-oil" production is going on in east Texas, where the oil is tapped near the surface and forced out by discharging natural gas so as to leave much of the oil irretrievably lost underground. Also, in the mining of coal and metals, private operators have been inclined to abandon mines only partially developed, with permanent loss to the nation, because a mine once abandoned is dangerous to reopen. Likewise, there has been waste in cutting over timber lands with only small regard to reforestation.

The surface activities of timber-cutting and plowing have also upset the natural balance that held in check floods, soil erosion, and dust storms. The accompanying Fig. 2, from the book *Little Waters*, published by the Soil Conservation Service, Resettlement Administration, 1935, indicates that only one part of rainfall in four will run off of forest land, carrying its complement of eroded top soil. Meanwhile leaching, as well as soil depletion through intensive agriculture, has robbed the soil of those essential chemicals—nitrates, lime, potash, and phosphates—on which plant growth depends, and the plants themselves have suffered. It is now known that although vegetables may look the same, they may not be the same in chemical content. To replenish the soil we can obtain nitrates from the air, and we have ample rock deposits of potassium and lime, but our phosphates stored in human bones find their way into countless untouchable cemeteries, and our only other sources of phosphates, Western deposits from prehistoric fossil bones, are very limited in extent. It is imperative that we retain on the land what soils we have, with the minerals that they still contain.

Turning now from land to labor (the human element in production), we are faced at once by the fact that about eight million people are unemployed, living on relief and often in slums, many of them unfitted for work through long absence from industry. This is sometimes attributed to the displacement of men by machines, but there is a contrasting theory that science makes jobs—that technical progress actually creates more jobs than machinery displaces. This latter theory seems plausible enough when applied to the great expansion of the past, but is it true today?

Perhaps we can learn the answer by examining pertinent figures on the ten-year period of business growth from 1919 to 1929. In 1919 the war had ended and business was entering a period of enlarged activity. New industries like radio were opening up, and automobile pro-

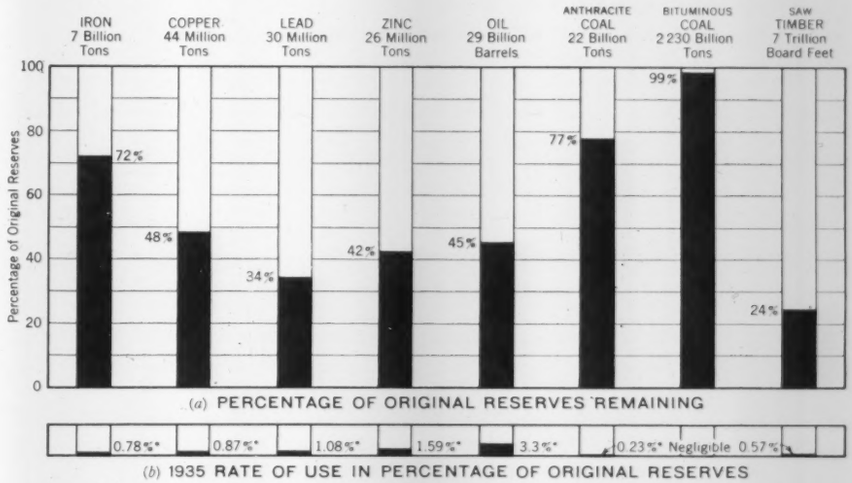


Fig. 1. Status of Certain Resources of the United States as of 1936
The Starred Data Are from *The World Almanac;* Other Data from *Rich Land, Poor Land*, by Stuart Chase

duction was being stimulated by new highway systems. Certainly in this period industry should have kept employment at least abreast of our 16 per cent increase in population if technological developments make jobs.

The accompanying curves (Fig. 3) on this ten-year boom period, drawn from data in *Recent Social Trends* (prepared by a committee appointed by President Hoover

FIG. 2. INFLUENCE OF VEGETATION UPON SOIL AND WATER LOSSES IN THE UNITED STATES

From *Little Waters*, Published by the Soil Conservation Service, Resettlement Administration, 1935

and published early in 1933), show that while employment in United States manufactures in that decade increased from an index number of 100 to 144.7, the number of persons engaged seemed to decrease from an index number of 100 to 94.5. Other figures from a recent economic bulletin of the Chase National Bank attempting to disprove technological unemployment, adjusted to a 1919 base and plotted here by *x*'s, show employment only slightly below 100 over most of this boom period and finally rising to about 103. No figures from any source indicate that employment kept abreast of the 16 per cent increase in population, although production kept well in advance of population because of the increasing output per worker. That is the extent to which technological unemployment existed during the last boom.

Of course the wage-earners were paid steadily higher wages during this period, as indicated by the new curves (Fig. 4) drawn from data in *Recent Social Trends* (which, by giving the average annual real wages adjusted for unemployment, automatically provide an index of total real wages). These are given in terms of real goods that might be purchased. As the curve indicates, total real industrial wages rose from 100 to about 125. Meanwhile, however, the production curve, here shown again rose from 100 to 144.7, so that the large wage-earning class could not share proportionately in the goods it produced. It is fairly evident that the shaded area between the two curves is the amount by which others profited at the expense of the industrial wage earners, over and above what profits of this kind were already being made in 1919.

It is the wage-earning class which does the important consuming for the nation. Members of this class are forced by circumstances to spend almost all they earn, and all their spending goes directly into production again. As the wage-earners became increasingly unable, towards 1929, to buy the goods produced, production slackened. Installment buying on credit kept purchases artificially stimulated for a while, but also accentuated the crash that followed. The unsold goods piled up; the wheels of industry slowed down; and the result was a depression.

By 1932, production had dropped 31 per cent below its 1929 level, and industrial employment had dropped with it (see *Income and Economic Progress*, pamphlet by the Public Affairs Committee, National Press Building, Washington, D.C., 1937). At this point, consumers who were on a wage basis were as a class less able to consume than ever before. We were at the bottom of the depression; we had passed through what is known as a business cycle. Efforts have been made by some economists to relate business cycles to the weather, and even to variations in the proportion of the sun's surface covered by sun spots. The plain truth is that business cycles are produced by exploitation, and the upswing occurs only when wage-earners are again provided with the means for purchasing.

There seemed no hope of stimulation to industry by any of the outside factors that had taken us out of past depressions. There was no longer an American frontier to act as a safety valve; San Francisco was as badly off as New York. There were no more new foreign markets to which surplus goods could be sold; many of our previous foreign-market countries had become industrialized as a result of our own loans to them and were even taking away some of our other foreign markets. The upturn came only when the government, through public works and the dole, extended sufficient purchasing power to the wage-earning class so that it could once again buy the products of its own labor.

CAPITAL COMES FROM CONSUMPTION, NOT FROM SAVINGS

When we come to capital, the third factor in the production and distribution of real wealth, we encounter another time-honored theory and some more modern facts. The theory underlying the use of capital equipment in the form of machines and factories is that they are built from savings, and deserve a continuing reward in the form of compound interest for which precedent has established the fair rate as 6 per cent. For instance, a man saves part of the fruits of his labor to build a machine; with this machine his labor is made more fruitful and so he is able to build more and more machines and produce more and more goods. Since he saved some of the wealth produced by his labor to build the machine, which is true capital, the theory says that any money which has been saved is also capital—that it is somehow automatically invested in production equipment and deserves to earn interest compounded at 6 per cent.

This theory about capital is not well supported by the facts. In the first place, actual production could not continue growing indefinitely at the rate of 6 per cent; our already declining resources would soon halt the process. However, some smaller rate of interest might possibly be valid. If we look at the production curve in the boom period from 1919 to 1929, with its ten-year increase from 100 to 144.7, it would seem that an annual growth rate of 3.8 per cent occurred; but since the production curve from 1929 to 1932 dropped below 100 again, it would also appear that a fair rate of interest for the entire cycle would be somewhat less than 3.8 per cent. That part of the theory which says that money saved by investment goes directly into production, was studied critically by the Brookings Institution, with the result shown on the accompanying chart, Fig. 5 (from the pamphlet *Income and Economic Progress*, previously mentioned). At the bottom of the chart are the amounts of increase in capital goods in typical years from 1919 to 1933, and at the top certain other annual quantities with which new capital goods seemed to vary quite satisfactorily. These other annual quantities are amounts of consumer's goods produced. That is, new capital goods were produced as con-

sumption demanded, and new capital varied with spending instead of with saving. New plants were created out of the money spent by the consuming public.

These facts evidently make somewhat doubtful the theory which justifies the rewarding of money savings with compound interest, and they also limit the fair return on real capital in modern society to a much smaller rate than 6 per cent. Yet, along with high rents, high salaries, and bonuses to management during the boom period, stock dividends and bond interest were generally maintained at rates of 6 per cent or better, often on watered stock issued on the strength of anticipated earnings.

Meanwhile money used in banking, where it is properly only a medium of exchange, was earning not only its own compound interest, often at 6 per cent, but interest multiplied many times over by the processes of credit. Over 80 per cent of our money in use today is not actual currency but credit money in check form. Since credit funds also bear interest, the basic real money thus earns its own interest and in addition the interest on all the credit piled on top of it. To quote Ely's *Outlines of Economics*, "It is estimated that a dollar of gold in our federal bank reserves will support considerably more than ten dollars of bank credit." These money operations are legal, yet they contribute to exaggerated private profit.

MALDISTRIBUTION OF INCOME IN 1929

It might have been expected that as a result of these discrepancies between fact and theory, some disproportions would grow up in the distribution of income. Two years ago the Brookings Institution completed a four-volume economic study, on which the book, *America's Capacity to Consume*, was based. This book disclosed a number of interesting facts relating to actual conditions in 1929, a year of presumed prosperity.

In 1929, as illustrated in Fig. 6, 0.1 per cent of the nation's families, having incomes of $75,000 and more, received 10 billions of the 77 billion total income going to all families; whereas 42.4 per cent of the families at the bottom of the scale, having incomes of less than $1,500, received only the same amount, 10 billions. This was the most top-heavy distribution of income in American history, yet according to the Brookings' findings, the tendency towards this kind of concentration was still increasing, probably because of the effect of impounded private wealth.

A family income of $2,000 can hardly purchase more than the basic necessities of life; yet in 1929, 59.5 per cent of the nation's families were below that income level. At that time, also, 74 per cent of the nation's non-farm families were beneath the $3,000 level required to provide an adequate diet at moderate cost along with normal expenditures for home, attire, and other living.

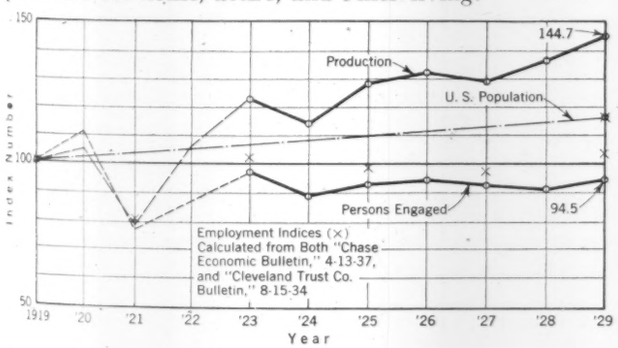


FIG. 3. PRODUCTION AND EMPLOYMENT, UNITED STATES MANUFACTURES, 1919–1929

Curves Drawn from Index Number Data in *Recent Social Trends*, Prepared by President Hoover's Research Committee, 1933

Again, the black circles in Fig. 6 represent income spent, and the open circles, income saved. Above $3,000 the tendency was to save more and more. Thus the higher income groups contributed proportionately less to the functioning of the nation's industrial machinery, for it is consumption that makes the wheels go round!

EFFECTS OF INCOME CONCENTRATION

The findings of the Brookings Institution show that despite a distinct lack of general welfare, the amount of idle productive plant in 1929 was something like 20 per cent, increasing to as high as 50 per cent during the ensuing depression. This unused plant capacity was clearly due to lack of consumption, and that in turn to maldistribution of income.

As has been pointed out, the reason is that the very rich divert much of their income away from consumption into savings, which often take the form of stock-market purchases and foreign loans. Stock-market purchases on the grand scale which the rich find possible contribute to those dramatic incidents in American life called stock-market crashes. Foreign loans have the interesting effect of building capital plants in previously undeveloped countries, thus enabling them to compete with us for dwindling foreign markets, at the same time stimulating imperialistic dreams that will probably lead to war.

Behind these major evils of income concentration are subtler effects—among them the influence of maldistribution of income on the architecture and character of our cities. History seems to prove that an invariable effect of industrialization, particularly of the exploitation that appears to go with it, has been the creation of slums. Modern cities lose in attractiveness by having their fine buildings set against backgrounds so discordant.

Meanwhile the human products of the slums make us biologically less competent to deal with the increasingly complex problems of living. It is imperative to provide a better environment and training for the poorer classes, who under present conditions can see no opportunity ahead and can have no chance in competition with the great concentrations of income that exist today.

THE NEED FOR PLANNING

As we complete this survey of social conditions, we should recall Tregold's definition of engineering as "the art of directing the great sources of power in nature for the use and convenience of man." Ordinarily, the engineer opens up new powers and opportunities; in the creation of society's ailments he has been involved only by the commendable achievement of increasing the output per worker. It is now his task to see that society benefits from such achievements.

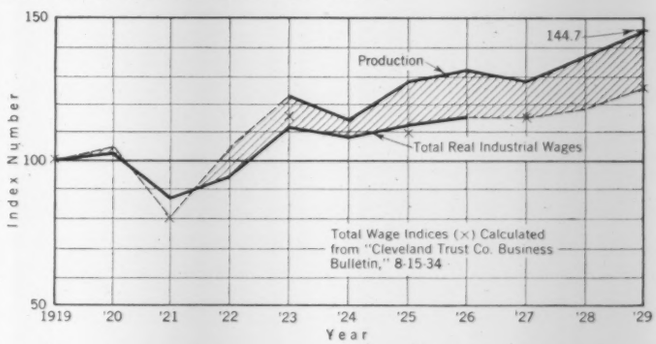


FIG. 4. PRODUCTION AND TOTAL REAL WAGES IN THE UNITED STATES, 1919–1926 (WAGE CURVE ESTIMATED TO 1929)

Wage Curve Drawn from Data in *Recent Social Trends*, Based on Real Wages in Manufacturing, Coal Mining, and Transportation

After a survey of this kind, the first impulse of the engineer would be to propose that society plan its course. But the word "plan" is in disrepute; it seems that because Russia has a plan, we must not have one. Yet mutual planning is necessary, if for no other reason than that specialization makes human beings mutually dependent. Industry should plan its course, but if it will not do so, then the government must.

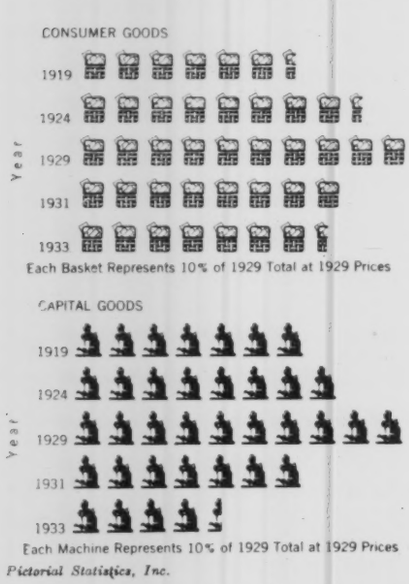


FIG. 5. FLUCTUATION IN PRODUCTION OF CONSUMER AND CAPITAL GOODS IN THE UNITED STATES, 1919–1933

From the Pamphlet, *Income and Economic Progress*, by the Public Affairs Committee, National Press Building, Washington, D.C., 1937

The first opportunity for national planning is of course in connection with land and water resources, the base on which society rests. Recurring floods, the increasing erosion of soils, and the loss of forests are problems which so transcend state boundaries that only the national government can deal with them. The states must relinquish the authority that will make possible an integrated program employing dams, reservoirs, cover crops, crop control, and reforestation to restore nature's balance. Denmark has given us a lesson in land planning by doubling its forest area in the last 75 years. It would seem that all land, with the resources it contains, ought to be regarded as belonging to society. In particular, resources beneath the surface, being irreplaceable, must be protected against wasteful mining and production practices.

But since it is true that even with completely efficient production we shall presently have a shortage of some resources, two other remedies must be considered, in which the engineer should take the initiative. One is more efficient utilization, where that is possible, and the other is the use of substitutes, particularly for fuels. It is said that a gasoline substitute can be prepared to sell for 23 cents per gal by combining alcohol with hydrocarbons manufactured through the hydrogenation of soft coal. But under the present business set-up, a dangerous oil shortage would have to develop before the substitute could be marketed at that price. It seems imperative, therefore, that industry or the government should take up at once the manufacture of this substitute, bringing its price down by quantity production to the point where it would displace gasoline and conserve the oil supply.

Finally, as to industry itself, where past exploitation continues to take its annual toll from society in the form of unearned income on large accumulations of wealth, it seems morally right that society should retrieve this wealth by means of an annual capital tax on excessive fortunes. At the same time the exploitation which is still taking place should be stopped. The forces that led to the 1929 crash are at work again; prices are rising faster than wages, and some form of regulation is needed to prevent the next depression, which is not far away.

A FEW REFORMS PROPOSED

First, we would propose that the formation of credit be made entirely a function of the federal government, not only because society ought to benefit by whatever profits are made in this field, but also because the Constitution specifically states that Congress shall have the power to coin money, and credit money is today much more important than currency. The second proposal would be that corporations be more uniformly regulated, to ensure that society will benefit, by low prices, from large-scale activities. In his book, *Trend of Business*, A. B. Adams makes the excellent suggestion that corporations receive their charters from the federal government instead of from the states. This would make possible the following social measures:

1. All corporations should have but one kind of fixed par-value stock to replace all existing issues of bonds, preferred stock, and common stock. For the larger corporations permissible dividends on these new stocks should be limited to a rate less than 6 per cent, which would probably be determined by the rate of interest currently paid on long-term government bonds. For the smaller corporations, dividend rates might be made practically unlimited in order to encourage initiative.
2. Bonuses to management should be eliminated and corporation salaries should be limited to $75,000 annually, the salary of the President of the United States.
3. All corporation surpluses resulting from these economies should go towards lowering the prices of manufactured goods (following the price-lowering recommendations of the Brookings Institution), and otherwise

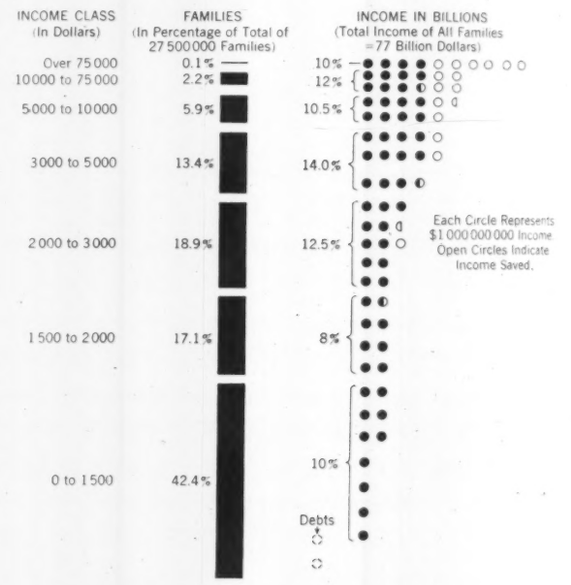


FIG. 6. DISTRIBUTION OF INCOME TO FAMILIES BY INCOME CLASSES IN 1929

Based on Data from *America's Capacity to Consume*, by the Brookings Institution, 1934

into increased wages for labor. Thus society would benefit continuously from improved technical methods.

Such controls would ensure a continuing flow of the fruits of production to society at large and would thus straighten out the business cycle. Industry would be stimulated by larger purchases, and employment would be automatically improved until, with the greater acquisition of real goods by society at large, slums and their discouraging products would disappear from the American scene.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Use of Reinforced Brickwork in Lincoln Tunnel Buildings

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THOUGH reinforced brickwork is not suitable for all purposes, there are many cases in which it may be made the chief part of the supporting structure. It is my purpose to show how its use resulted in simplicity, efficiency, and economy in certain portions of the three ventilation buildings of the Lincoln Tunnel, which is being built by the Port of New York Authority between West 39th Street, New York, N.Y., and Weehawken, N.J. Although these structures are "special" in many respects, the solutions of some of the design problems should be of value to those engaged in other types of work. In general, the buildings are fireproof, steel-framed structures with brick walls, concrete floors, and gunite air ducts. The idea of utilizing reinforcement in the brickwork developed in the design of the 15-ft parapets for the first one to be built (the New York River Ventilation Building, shown in the right background of Fig. 1).

Because of setbacks in the exterior brick walls, the columns, if extended above the roof line, would have had to be offset on to the roof beams and braced to them to provide lateral stiffness. Beams would also be needed to tie the tops of these columns together and to brace the walls, for it seemed unwise to leave such tall parapets free-standing. On the whole, it appeared that any such framing to support the parapets would cut them into separate units. It was therefore decided to utilize the strength of the 12-in. brick walls themselves, with the addition of enough rods to reinforce them properly.

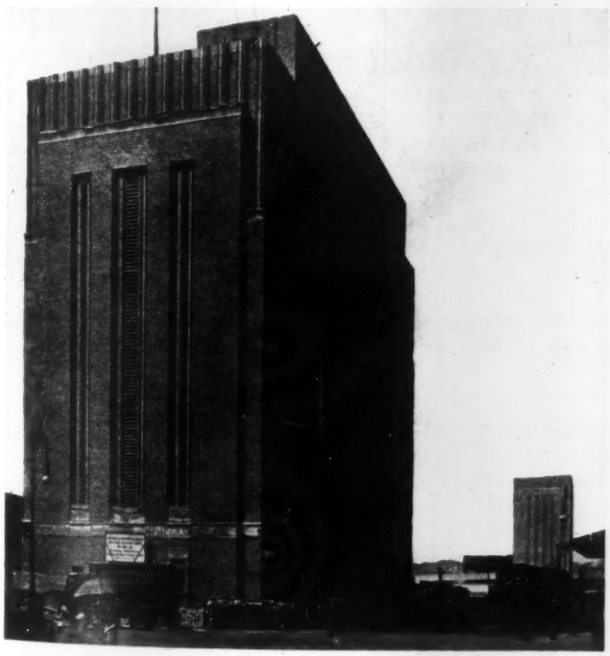

FIG. 1. VENTILATION BUILDINGS AT THE NEW YORK END OF THE LINCOLN TUNNEL

Construction of the parapets was simple. They were made in panels, with pilasters at convenient points (Fig. 2). The panels were reinforced horizontally by two $^1/_4$-in. round galvanized rods in every fourth course, and the pilasters were reinforced as vertical cantilever beams with four $^3/_4$-in. round rods, spliced to dowels anchored into the concrete roof slab. In this manner the entire parapet structure was knitted together thoroughly and tied into the rest of the building.

FIG. 2. PARAPETS OF THE TUNNEL VENTILATION BUILDINGS
Left, Junction of Panel with Pilaster; Right, Partially Completed Parapet

The $^1/_4$-in. diameter of the horizontal rods was determined by the requirement that they must be thoroughly embedded in the mortar in the $^3/_8$-in. joints. Placing them in pairs in every fourth course, instead of singly in alternate courses, simplified the bricklaying. The rods were galvanized to make sure that future weathering would not stain the light buff face bricks.

The next application of reinforced brickwork was in the walls of the airtight exhaust-fan rooms of this same building. Some of these walls have a height of about 24 ft and a clear width of 20 ft. They are subjected to a considerable bending moment by the combined load of the outside wind pressure and the severe suction of the fan. Intermediate steel spandrel beams with concrete encasement had been designed to support them both horizontally and vertically. However, these beams were eccentrically loaded, because they had to clear offsets and slots in the outside faces of the walls. They were not

braced laterally. Further, they seemed to be objectionable from the standpoint of the appearance of the inside of the fan room. Hence they were eliminated, and two $^1/_4$-in. round galvanized rods were added in every fourth horizontal joint of the brickwork. These rods were extended to the building columns, which were designed to withstand the bending moment due to lateral forces. The walls thus became simply-supported, vertical, reinforced-brick slabs, the weight of which was supported by the main spandrel beams at the floor lines.

FIG. 3. DETAIL OF WALL CONSTRUCTION, SHOWING TYPICAL SLOT

The second ventilation building to be designed was the one on the New Jersey side of the river. A new situation developed here in connection with the "Evasé stacks," or exhaust ducts. These stacks were wedge-shaped. Their smaller ends, about 8 ft square, were connected to the exhausters at the ceilings of the fan rooms. From that point they flared uniformly (in one plane) to dimensions of about 8 ft by 21 ft at the top of the building. They were composed of reinforced-gunite walls $2^1/_2$ in. thick.

Above the sixth floor these ducts were in contact with parts of the north wall of the building. These portions of the wall had a height of 34 ft and a panel length of 22 ft 3 in. When the structural design was already well advanced, it was decided for architectural reasons to make vertical cuts, or slots, 8 in. deep in the outside faces of all walls at this level. These cuts figuratively pinched off the spandrel beams because the latter could not be moved without encroaching upon the ducts.

It was inadvisable to change the general plans. Therefore, heavy beams were placed under these walls at the sixth floor to carry their entire weight. One galvanized $^1/_4$-in. round rod was placed in every fourth course (Fig. 3) to tie the walls together, and to connect them to the corridor columns and the side walls. The rods and the adjoining reinforced-gunite construction of the stacks, stiffened the walls sufficiently to do away with the spandrel beams.

The New York Land Ventilation Building (Fig. 1, foreground) utilized reinforced brickwork to an even greater extent than the other two. The roof is located a short distance above the top of the louvre in the front face. The taller portion of the structure encloses the elevator machinery room, the space for the water tank, and eight Evasé stacks. This portion of the structure is about 19 ft wide and 102 ft long and rises to a height of 30 ft above the roof. From its ends, brick parapets 16 to 18 ft tall extend around the rest of the building.

The 3-in. gunite walls of the Evasé stacks were too tall and flimsy to carry their own weight if they merely rested upon the roof. However, if a structural steel frame had been used for support, its columns would have had to be offset at the roof line. Also, a set of beams with concrete encasement would have been needed at the centers and tops of all ducts. Furthermore, because of the desired sequence of construction operations, it was necessary to plan the procedure so that the gunite work could be carried on after the rest of the structure was completed.

Since 12-in. brick walls surrounded the stacks, it seemed feasible to use them as the duct supports. Therefore, all the steelwork of the building was stopped at the roof level. The main walls were placed along two sides of the ducts. Brick cross-walls 8 in. thick were built next to the other two sides of each Evasé stack, thus forming a cellular structure with ten vertical compartments. The weight of the entire construction was carried by the roof beams. All these walls were reinforced horizontally with two $^1/_4$-in.-diameter galvanized rods every fourth course. All corners and intersections were tied with bent rods. The number of rods used was arbitrarily chosen because their function was that of knitting the structure together rather than of resisting bending.

The details of the work (Fig. 4) were readily adapted to the desired sequence of construction. Steel beams were placed under each wall at the roof level, and encased in concrete, leaving keys and dowels for the attachment of certain duct construction below the roof. The brickwork was next completed. Finally, the gunite of the parallel sides of the stacks was shot directly on to the bricks, being bonded to them by $^1/_4$-in. rods and the keying effect of raked joints in the brickwork. The sloping end walls of the ducts were tied into these side walls with mesh and dowels. The weight of the gunite was therefore transferred directly into the brick cross-walls.

The saving due to the use of reinforced brickwork for these structures, in place of the steel-and-concrete framing originally planned, is estimated to be over $5,000, on a total estimated cost for the portions involved of about $50,000. The use of reinforcement caused no special labor difficulties. At first, the bricklayers were rather slow in realizing that the rods had to be in definite locations, lapped at splices, and bonded at corners. However, they soon learned how to arrange the steel and to conduct the work with no appreciable delay. On the other hand, some additional work was involved in the erection of supports for scaffolding.

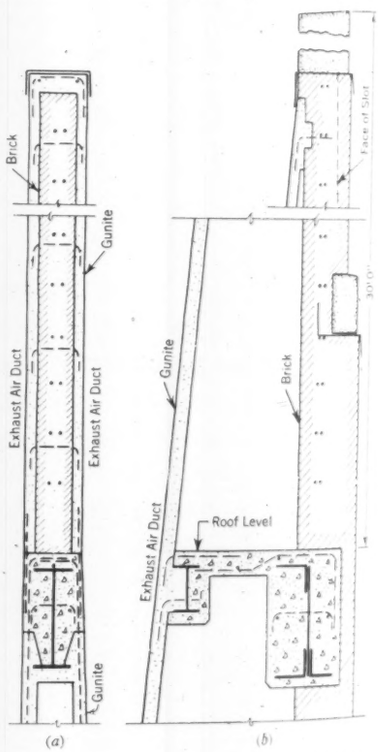

FIG. 4. EVASÉ STACK CONSTRUCTION
(*a*) Cross-Wall, (*b*) Exterior Wall

In conclusion, certain general precautions in regard to building reinforced brickwork should be pointed out. The horizontal rods should be small in diameter, so as to avoid the necessity for wide mortar joints; they

should be laid on the bricks prior to the placing of the mortar, to insure that they will be thoroughly embedded; and they should be arranged so that no two rods cross each other in the same joint (if crossing of reinforcement is necessary, the rods that cross should be placed in alternate courses). The work should be planned so as to have proper bonding of the horizontal rods at any junction between walls that are built at different times. Vertical rods, as in pilasters, should be placed back of the face course, so that the corners of the backing bricks can be knocked off to provide an adequate space for mortar around the rods without affecting sizes of vertical joints.

Analysis of Stress in Pedestals

By FRANK SCHAFFEL, JUN. AM. SOC. C.E.
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The following article is presented as an example of the work done in the Student Chapters. Written by Mr. Schaffel while he was an undergraduate, the paper of which this is an abstract was awarded first place in a contest among the eight Student Chapters of the Metropolitan Area last spring, and later won similar ranking at the regional conference of Student Chapters in northern New York, held at Rensselaer Polytechnic Institute.

IN designing shallow spread footings, a considerable saving may be effected by using a pedestal to spread the column load over a larger area of the footing. Pedestals are designed on the assumption that the stress is evenly distributed over any cross-section, and that the load is transferred to the footing uniformly. The object of this article is to give results of experimental tests which show when and why these assumptions are correct or incorrect, and to bring out other features which may affect the design.

The tests were made on two-dimensional models with photoelastic apparatus. Although pedestals and footings are really three-dimensional, a test on a two-dimensional section is a fair approximation to actual conditions, and the results of the analyses can be applied to actual pedestals.

Briefly, the photoelastic method is as follows: A model similar in form to an actual pedestal is cut from some material which normally allows light to pass through it unaltered in any manner (isotropic material). It is then put in the polariscope and loaded in a manner similar to actual loading, and its image is projected on a screen. As load is applied the following changes occur:

1. Alternate black and white bands (isochromatics) appear. At every point of one of these bands the difference between the principal stresses is the same. Therefore these are lines of equal shear [Fig. 1(*a*)].
2. Upon rotation of the two polarizing prisms, a set of black lines (isoclinics) appear in succession. At every point of one of these lines the direction of the principal stresses is the same [Fig. 1(*b*), left].
3. From the isoclinics, lines of stress flow (stress trajectories) are drawn. At every point of one of these lines the stress flows in the direction of the line at that point [Fig. 1(*b*), right].

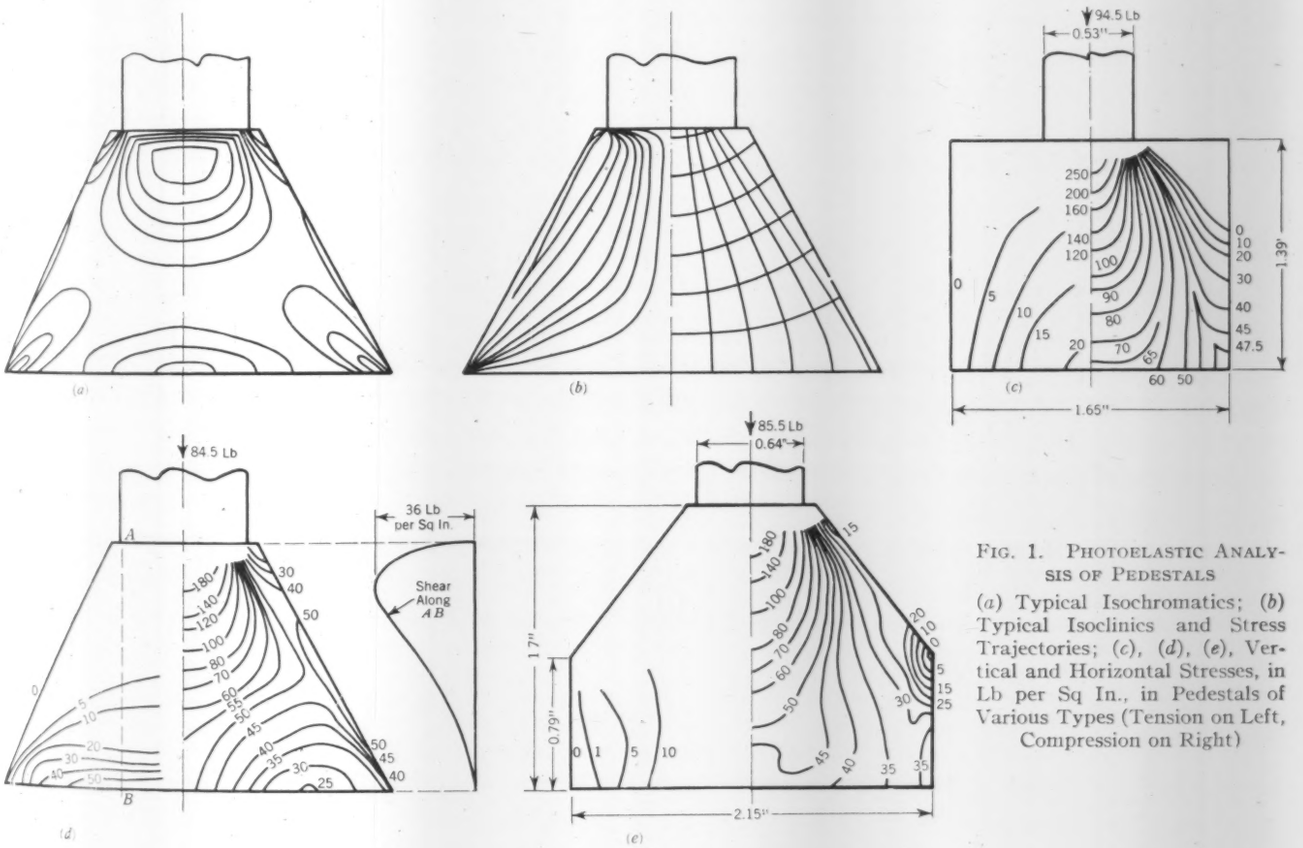

FIG. 1. PHOTOELASTIC ANALYSIS OF PEDESTALS

(*a*) Typical Isochromatics; (*b*) Typical Isoclinics and Stress Trajectories; (*c*), (*d*), (*e*), Vertical and Horizontal Stresses, in Lb per Sq In., in Pedestals of Various Types (Tension on Left, Compression on Right)

With these data the values of the principal stresses are computed at several points along each trajectory. These stresses may then be resolved into horizontal and vertical direct stresses and shear stresses.

Originally six models of various shapes were tested, but only three are discussed here, as they cover all the features found in the whole set.

In Fig. 1(*c*) is shown the sectional elevation of a rectangular pedestal of breadth slightly greater than its height. To picture more clearly the stress conditions throughout the model, contour lines of stress have been drawn. On the right side of the vertical axis are plotted lines of equal vertical stress (compression) and on the left side are shown lines of equal horizontal stress (tension).

These contours tell the whole story. The stress is highly concentrated directly beneath the column, while a large portion in the upper corner of the pedestal is completely devoid of vertical stress. At the base of the pedestal the stress is not evenly distributed. Evidently this pedestal is not tall enough to develop a uniform distribution of the load at the bottom, and on no horizontal cross-section within the pedestal is there an even stress distribution.

In Fig. 1(*d*) is shown a model with sharply sloping sides and a base which is wide with respect to its height. Because the sides are sloped, no portion of the pedestal is unstressed, but there is a high concentration of stress beneath the column. This condition results from the shortness of the pedestal with respect to its base width. To the right of this figure is a curve of shear along the line *AB*, which shows that the shear is concentrated near the top of the pedestal. Shear curves for other models are similar. Therefore designs for the depth of pedestals based on a uniform punching shear are considerably in error.

It is to be noted that the horizontal tensile stress is highly concentrated in the vicinity of the lower corner. It appears, then, that tensile stresses are high near acute corners, and are negligible near square corners—like those in Fig. 1(*c*). One might then expect acute corners to chip off, and experience has proved this to be the case. Hence, why not cut off the corners?

Fig. 1(*e*) shows such a model. This model is also taller with respect to its base width than the others. Because of this the stress distribution at the base is almost uniform. At the cut-off corner the horizontal stress is almost eliminated.

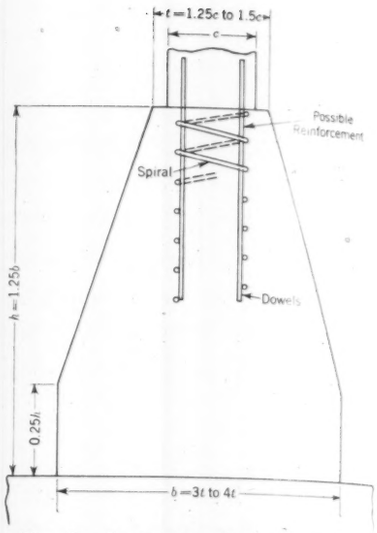

FIG. 2. SUGGESTED PEDESTAL DESIGN

From these investigations certain general conclusions may be drawn. The uniformity of stress distribution to the bases depends upon the height of the pedestal. Acute corners produce high tensile stresses. Vertical shear is high near the point of load application. If the top width of the pedestal is much larger than the column base, then large parts of the pedestal will be unstressed and of no use. Finally, there is always a high concentration of vertical stress directly under the column.

A suggested pedestal design which takes into account these observations is shown in Fig. 2. In order to utilize the allowable unit stress of the concrete at the base of the pedestal, a system of reinforcement must be put in at the top to take the high stress concentration directly beneath the column. This design also takes care of the shear which is concentrated at the top of the pedestal.

Forecasting Rainfall by Mean Seasonal Distribution

By HENRY WENDEROTH

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Like the preceding article, Mr. Wenderoth's study of rainfall prediction illustrates the work done in the Student Chapters. It was one of the prize papers submitted to the Portland Section last spring by members of the Student Chapter at Oregon State College. The abstract presented here represents only a small part of the original paper.

ALTHOUGH a large amount of work has been done on seasonal rainfall forecasting by numerous different methods, much remains to be accomplished before satisfactory results can be had in all cases. The method described here, which involves comparing the rainfall to date with the normal percentage of mean annual rainfall for the same date, was investigated for some 13 Oregon stations by A. F. Johnson in his studies for a graduate thesis at Oregon State College in 1933. His results were so gratifying that it seemed desirable to expand the method and apply it to California stations.

As California is one of the largest states in the Union, the selection of a limited number of stations that represent all types of rainfall was fraught with many difficulties. The U. S. Weather Bureau has divided the state into four climatological sections, and it was desirable to have all these sections represented. However, from Mr. Johnson's study it is evident that in very arid regions the percentage of mean rainfall is so variable as to make the method unreliable for forecasting until February or March of the current "water year," and that even then the percentage errors will be much larger than for stations where there is more abundant and less variable rainfall. Hence it was decided to take only two stations from the more arid central and southern California sections; the remainder were from the northern part of the state.

FIG. 1. CALIFORNIA: CLIMATOLOGICAL SECTIONS, AND STATIONS STUDIED

Numerous factors were involved in this selection. The reliability of records was an important factor; it was assumed that all the major stations directly under the Weather Bureau and inspected by it were sufficiently reliable bases for computations. The length and continuity of records were also considered, and all stations with less than a 20-year record were eliminated. Finally, from the remaining list, 13 stations were selected for analysis (Fig. 1).

COLLECTING AND COMPUTING DATA

The rainfall data for each of the stations for the rainfall year (July 1–June 30) were tabulated by monthly accumulation. The percentage that each month was of the total accumulated rainfall for each year was next computed. Then the mean rainfall for each month for the entire period of record was obtained and the mean accumulated per cent calculated.

The probable deviation, e, for each month for the various stations was computed from $e = 0.6754c_v$. The coefficient of variation, c_v, is $\sqrt{\frac{1}{N}\left(t - \bar{t}\right)^2}$, in which N is total frequency, or number of years of record; t, value for any month; and $\bar{t}$, mean value for that month.

From these data a chart like Fig. 2 was prepared for each station. The maximum and minimum values of accumulated per cent of annual rainfall were selected from the precipitation data and plotted as an envelope about the mean curve. The probable deviations are also shown. At both ends there is considerable skew in the latter curves, due to the dryness of the summer season and lack of rainfall in the early spring, which results in a small difference in the value of the means for successive months. Since forecasts for the year cannot be made on the first month or two of record, and since forecasts made during the last month or two of the rainfall year are of no practical value, this skew at the ends is relatively unimportant. Through about seven months of the year, the distribution about the mean is practically normal.

One of the striking characteristics of the curves for California is their regularity; the values of the means and probable deviation approach a straight-line relation from the last of November to February or March. This fact should also prove of advantage in making the forecasts.

USE OF CURVES

The mean values of total rainfall for the year vary from a little over 9 in. at Fresno to almost 75 in. at Crescent City. In the northern California stations, the mean accumulative per cents are all quite regular even though the quantity does vary enormously. In central and southern California, forecasting by this method is more or less uncertain owing to the occurrence of drought periods and of occasional heavy storms or cloudbursts, which represent a large percentage of the season's precipitation.

As an illustration of the method of making a trial forecast, the following example is taken: Place, Crescent City, Calif., January 31, 1927; total rainfall since beginning of water year, 63.00 in. It is required to predict the total rainfall for the water year. From the mean annual percentage-of-rainfall curve, the mean value of the accumulated percentage at the end of January is found to be 58 per cent. Hence the predicted value is 63.00 ÷ 0.58, or 108.2 in. The actual rainfall was 102.5 in., which made a percentage error of 5.5 per cent.

Starting in at the end of December, forecasts were made for all the stations, for ten different years selected at random. The average percentage of error in the case of Crescent City was well under 15 per cent, and other coastal stations south to San Francisco compared favorably with this. The remainder of the stations in northern California gave results that indicated, with only one or two exceptions, whether the rainfall season to be expected would be average, dry, or wet, and in a majority of cases gave results within 15 per cent.

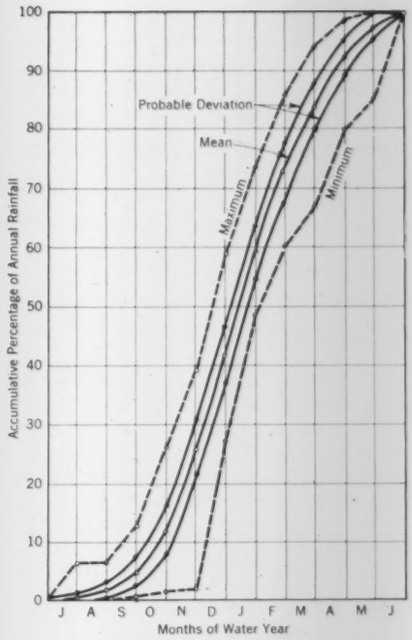


FIG. 2. ACCUMULATIVE PERCENTAGE OF ANNUAL RAINFALL, BY MONTHS, FOR CRESCENT CITY, CALIF.

Forecasts made at the end of January show a very decided increase in accuracy throughout the state. In no case were there misleading forecasts, and in the northern section of the state the percentage of error in the actual amount of rainfall predicted was approximately 10 per cent. As before, the errors in the stations in the southern section of the state were slightly higher, but sufficiently accurate in most cases.

Forecasts were also made at the ends of February and March with results still closer to the actual rainfall, as would be expected. Of course, by this time, a large proportion of the total rainfall has already occurred and the forecast loses a good part of its value.

The use of these curves, especially in forecasting the current season's supply as an aid to the operation of existing water supplies, is definitely indicated by the preceding trial forecasts. The occurrence of pronounced wet and dry seasons in California makes the use of this method of even more value. The predictions are close enough to be of practical value.

Short-Cuts in Preliminary Highway Surveys

By WALLACE W. SANDERS, ASSOC. M. AM. SOC. C.E.
DISTRICT ENGINEER, STATE DEPARTMENT OF HIGHWAYS, LOUISVILLE, KY.

A CHART that I have found useful in making preliminary highway location surveys is shown in Fig. 1. It reduces field computations considerably and saves the use of a field book.

The curves originating in the lower left corner are used in finding tangent offsets and middle ordinates. Those originating in the upper left corner are used only in finding lengths of long chords. Arc lengths in feet from P.C. or P.T. are to be read at the bottom of the chart when finding tangent offsets, and at the top when finding middle ordinates and long chords.

For example: (1) To find the tangent offset for a 4-deg curve at a point 200 ft from the P.C. along the arc, project a line upward from the 200-ft mark at the bottom of the chart until it intersects the curve for 4 deg, and read the answer (13.9 ft) at the left. (2) To find the middle ordinate of the same arc, project downward to the 4-deg curve from the 200-ft mark at the top, and read the answer (3.6 ft) at the left. (3) To find the long chord for a 400-ft arc of a 30-deg curve, project a line downward from the 400-ft mark at the top until it intersects the 30-deg curve for long chords, and read the answer (330 ft) at the right.

For convenience, the following note may be attached to the chart: "The distance from the P.C. or P.T. along the sub-tangent to the point of tangent offset equals one-half the long chord of twice the arc. Also, the normal offset, from a sub-chord produced to a point at a distance from the curve equal to the length of the sub-chord, is equal to twice the tangent offset from a line which is tangent to the curve at the same point that the sub-chord intersects the curve."

Another helpful short-cut is the following approximate formula for finding externals for a 1-deg curve without use of trigonometric functions:

Square the central angle (in degrees) and multiply by 0.22 if the central angle is 35 deg or less. Increase the multiplier by 0.01 for each 10 deg up to and including 75 deg, after which the multiplier is increased 0.01 for each 5 deg. Thus, the multiplier for a central angle of 54 deg is 0.24, and for one of 87 deg, 0.29.

For example, find the external to a 1-deg curve for a central angle of 53° 30′. The square of 53.5 is 2,862.25. The multiplier for a central angle between 46 deg and 55 deg is 0.22 + (2 × 0.01) or 0.24. Hence the external is 686.9 ft.

For a rough approximation of the external to a 1-deg curve, square the central angle and divide by four. The result is expressed in feet.

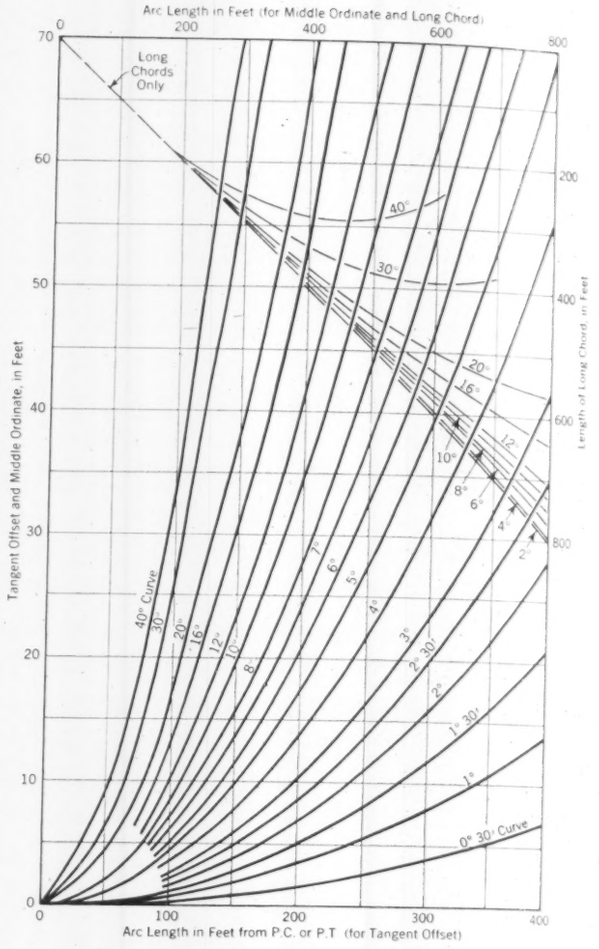

Arc Length in Feet (for Middle Ordinate and Long Chord)
Long Chords Only
Tangent Offset and Middle Ordinate, in Feet
Length of Long Chord, in Feet
Arc Length in Feet from P.C. or P.T. (for Tangent Offset)
40° Curve
0° 30' Curve

FIG. 1. FUNCTIONS OF CIRCULAR CURVES

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Fees for Engineering Services

DEAR SIR: The information published in the "Society Affairs" department of the September issue of CIVIL ENGINEERING regarding "Fees for Engineering Services—An Examination of Practices among Government Agencies," would be amusing if it were not so tragic. Why dignify a civil engineer of broad training and of recognized skill in a special branch of engineering by the title of "Consulting Engineer" or "Consultant" if the federal government values his services at the ridiculous per diem rates of $25 to $75.

There is little consolation for consulting engineers in the fact that "on rare occasions the Bureau of Internal Revenue has paid as much as $100." Rather than accept "as little as $10 per day" from the National Resources Committee, a dignified consulting engineer should donate his services to that Bureau. The Corps of Engineers of the United States Army should be commended for its efforts to improve the situation regarding the engagement of outside engineers by federal bureaus.

However, the officers of the Corps of Engineers should be advised that $75 per day as a per diem rate is not a suitable or desirable maximum for consulting engineering services. Any consulting engineer who maintains a suitable office, who keeps abreast of new developments in his particular field by study and travel, and who maintains a well-paid staff of skilled assistant engineers, can tell the Corps of Engineers that he cannot maintain himself by engineering engagements on a per diem basis unless the per diem rates are considerably higher than $75. Such consultants will testify that the bulk of their income must come from suitable percentage fees. Only when there is a fair volume of such percentage fees or equivalent lump sum fees can a consulting engineer maintain himself properly.

I believe that our Board of Direction received this report of the American Engineering Council too placidly.

Further vigorous presentations should be made to the officials in charge of the federal bureaus in an effort to discourage the custom of extending to consulting engineers inadequate fees. If per diem fees are to be paid, they should be increased in amount. However, a strong effort should be made to encourage the federal bureaus in paying for outside engineering services by means of percentage fees or lump sum fees, just as is done now by well-administered municipalities, counties, and industrial firms.

ARTHUR W. CONSOER, M. Am. Soc. C.E.
President and General Manager,
Consoer, Townsend and Quinlan

Chicago, Ill.
September 24, 1937

Application of Maps to Highway Surveying Practice

TO THE EDITOR: The most important modern developments mentioned in the paper by J. C. Carpenter, M. Am. Soc. C.E., in the July issue, are aerial photography and the use of geodetic control reduced to rectangular coordinates.

By geodetic control is meant the U. S. Coast and Geodetic Survey triangulation survey, or an extension of it into unsurveyed areas. This is the one basic control that should be used for coordinating all surveys by all agencies.

An "air-photograph" is not a map, but a perspective. A map can be made from the photograph by introducing "ground control," thus giving correct orientation and a mathematical scale.

The use of these two should secure the detail of the aerial photograph, the accuracy of the geodetic control, and the ease of computation of plane surveying, instead of spherical.

Probably, in the not distant future, it will be required either by regulation, law, or custom, that the highway right-of-way map be filed with the county deed records. If we can picture such a right-of-way map possessing all the features just mentioned, with the coordinates of selected points given, and these being permanently monumented, we can realize its greatest value and the many uses it would have.

To mention one such use—land boundary surveys in areas adjacent or nearby could be easily tied in and thereby obtain the same accuracy and control.

While present highway surveys are fairly accurate within themselves, they are usually done piecemeal by projects, or at most by counties, and are not tied together. By use of the geodetic control, the projects would be shown in correct relative position by their coordinates, even if they were widely separated. The coordinates shown on the right-of-way map could be carried through and shown on the project plans.

Probably aerial photographs are of greatest value to highway surveys in the reconnaissance, or preliminary, stage. This allows an intelligent study of the surrounding terrain.

Of the two modern developments referred to, the one of greater importance to highway surveying is the use of the geodetic control, reduced to rectangular coordinates. In Texas the latitude and longitude of the triangulation stations of the Coast and Geodetic Survey are reduced to rectangular coordinates by the Lambert Conformal Projection, thus allowing traverse computations by plane-surveying methods.

Engineers are notoriously slow to adopt new methods and new developments, but these two are so valuable and so easy to use that they should become general practice soon.

T. W. BAILEY, M. Am. Soc. C.E.
Division Engineer, State Highway Commission
and
MASON JOHNSON, Assoc. M. Am. Soc. C.E.
Resident Engineer, State Highway Commission
Corpus Christi, Tex.
September 23, 1937

Computing Settlement Stresses in a Multiple Frame

TO THE EDITOR: Since the moments due to settlement and lateral displacement of the Corona Yard continuous bent computed by the engineers of the Interborough Rapid Transit Company differed appreciably from those computed from the formulas given by Anders Bull, M. Am. Soc. C.E., in his article on wire model analysis in the August issue, it may be of interest to point out what seems to be a flaw in the application of his method in this particular case, even though the method itself is no doubt accurate, as he shows by arriving at consistent results with both model and mathematical analysis.

We used the Cross moment-distribution method first, and checked it later with the slope-deflection method, obtaining very consistent results also. Since both sets of results are supported by an independent check method, it may be conceded that all solutions are correct, but evidently two different problems were solved. The initial data taken in the field, as shown in Fig. 1, consisted of the relative elevations of the bottoms of girders A and B, and the offsets to plumb lines suspended from the tops of columns C_1, C_2, and C_3. Column bases are assumed to remain vertical.

Note that these measurements give the distortion of the frame and not merely the relative movements of the column bases, which, of course are easily calculated to be: $a = -1/8$ in. and $b = +7\frac{3}{4}$ in., for base C_1; and $c = +1$ in. and $d = +6\frac{3}{4}$ in., for base C_2, using Mr. Bull's notation with base C_3 as a datum. Now, if these relative base data only are used, the problem that Mr. Bull solved is the result. It amounts to assuming the upper part of the frame to be in the special case of equilibrium due to nine moments and reactions acting on the three bases. However, if the additional information is used that the upper part need not necessarily be in this particular position, but is in whatever general position the measured data show it to be, the solution of the Interborough Rapid Transit Company engineers is the result. In other words, the general solution requires the determination of ten quantities instead of nine, and is indeterminate to the seventh degree.

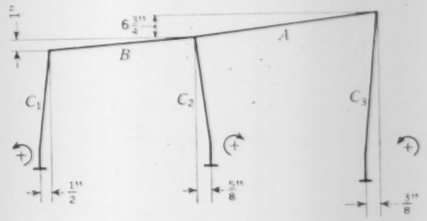


FIG. 1. ACTUAL MEASURED DATA ON SETTLEMENT OF BENT

The Cross method lends itself admirably to a quick solution whenever the relative positions of the ends of all members of a frame are known by measurement, as in this case. Table I shows part of the data necessary for such a solution. The carry-over factor is $+1/2$, and $E = 29{,}000{,}000$. Five distributions give results agreeing fairly well, and ten distributions give results almost exactly like those resulting from the standard slope-deflection method. Table II shows the results of both methods for the three-base moments and, for comparison, the results obtained by substituting the relative base displacements in Mr. Bull's formulas. His sign notation is used—that is, base moments producing tension in top of girder "A" are considered positive.

TABLE I. DATA FOR MOMENT DISTRIBUTION METHOD

MEMBER	STIFFNESS FACTOR $k = I/l$	RELATIVE END DEFL. D	FIXED END MOMENTS $M = 6DEk/l$
A	7.03	6.75	16,190
B	5.80	1.00	2,800
C_1	1.64	0.500	649
C_2	1.20	0.625	593
C_3	1.12	0.375	300

TABLE II. COMPARISON OF MOMENTS AT COLUMN BASES

	CONTINUOUS CONNECTIONS ASSUMED			MODEL WITH KNEE BRACES
Column	By Moment Distrib.	By Slope Deflection	By Use of Mr. Bull's Model Formulas	By Use of Mr. Bull's Model Formulas
C_1	+ 550	+ 553	−558	−1,113
C_2	− 33	− 33	−702	− 323
C_3	+1,156	+1,164	−370	−1,281

When the reactions are calculated from our moments, it is found that a horizontal external force of about 20,000 lb must have been acting in line with girders A and B to force them to the right of Mr. Bull's special case and to give the final distorted structure shown in Fig. 1.

ALFRED AFRICANO, Jun. Am. Soc. C.E.
Assistant Engineer, Interborough Rapid Transit Company
New York, N.Y.
October 8, 1937

Credit for Seismological Work

DEAR SIR: Some pertinent comments seem in order on the article by Jacob J. Creskoff, which was published in the September 1937 issue of CIVIL ENGINEERING under the title, "Buildings Have Pulses."

1. The design and construction of the shaking machine, illustrated in Fig. 2, and the measurements of buildings made with this machine were made in connection with the California Seismological Program of the U. S. Coast and Geodetic Survey—R. S. Patton, M. Am. Soc. C.E. Director; N. H. Heck, M. Am. Soc. C.E., Chief of the Division of Terrestrial Magnetism; and Franklin P. Ulrich, Assoc. M. Am. Soc. C.E., Chief of the Seismological Field Survey.

2. The actual design was made by Lydik S. Jacobsen, Professor of Mechanical Engineering in charge of vibration research at Leland Stanford, Jr. University, assisted by John A. Blume, Jun. Am. Soc. C.E.

3. This shaking machine, instead of being "a common form of shaking machine," is the only one of its kind in the United States and probably in the world.

4. "The Synchronism Curves for a Rigid Reinforced Concrete Warehouse," shown in Fig. 3, were made under the personal direction of Messrs. Ulrich, Jacobsen, and Blume on the Palo Alto Transfer and Storage Company Building, Palo Alto, Calif. This figure is essentially a reproduction of Fig. 10 of Mr. Blume's report of the work in the October 1935 Bulletin of the Seismological Society of America.

5. Many measurements of the periods, both natural and forced periods of buildings, elevated water towers, dams, and other structures, have been made under the California Seismological Program of the U. S. Coast and Geodetic Survey and have been reported in detail to the Seismological Society of America and published in its Bulletins. A total of eight such articles may be found in the January and October 1935 and the July 1936 Bulletins. Reference may also be made to "Earthquake Investigations in California, 1934–1935," Special Publication No. 201 of the U. S. Coast and Geodetic Survey.

Substantially all the measurements and observations forming the basis of Mr. Creskoff's discussion were made as part of the work of the Survey. This program has had from its inception the active participation and support of the California Sections of the American Society of Civil Engineers, the California Chapters of the American Institute of Architects, prominent faculty members of Leland Stanford, Jr. University, the University of California, and the California Institute of Technology. Therefore, it seems inappropriate that this material should be reported in a publication of the American Society of Civil Engineers by one who had but little part in the work; and without mention of what should have been generous credit to those whose work supplied the information he so freely uses.

HENRY D. DEWELL, M. Am. Soc. C.E.
Consulting Civil Engineer

San Francisco, Calif.
September 23, 1937

DEAR SIR: In replying to Mr. Henry D. Dewell's letter concerning credit for seismological work in connection with my article, "Buildings Have Pulses," published in the September 1937 issue of CIVIL ENGINEERING, I find that he is reasonably accurate in his statements with the following exceptions:

The term "a common form of shaking machine," although hardly a happy description of the Jacobsen-Blume device, is substantially correct. Vibrating machines of this type had been manufactured by Lösenhausenwerk, A. G., Germany, and have been in extensive use for a number of years. At least two of the latter devices are owned by the U. S. Navy. The Jacobsen-Blume shaking machine, undoubtedly an independent development with special features of its own, is of the same general type.

In so far as credits are concerned, it is pertinent to point out that in the past, authorization to use a number of the results of the California Seismological Project of the U. S. Coast and Geodetic Survey (officially reported in its *Special Publication No. 201*), was requested by the writer and granted by the Survey. The cuts shown in Figs. 2, 3, and 4 (the only ones involved by Mr. Dewell) were furnished by the Survey. Since these illustrations resulted from a project of the Survey, conducted by the Survey, and financed by the Survey, credit to the Survey seemed wholly proper. Such acknowledgment duly appears under Figs. 2, 3, and 4 in "Buildings Have Pulses."

In published material of more technical nature, where the reader might wish to consult the sources, I have referred specifically to the work of Jacobsen, Blume, and others—as well as to the Survey. Plainly, adequate credit has been given.

Turning now to the last paragraph of Mr. Dewell's letter, suggestion is made that the writer was not entitled to discuss the results of the California Seismological Program because he had "but little part in the work," the analysis of which Mr. Dewell seemingly seeks to establish as the subject matter of "Buildings Have Pulses." That the paper deals with the program is obviously contrary to fact, although illustrations are used which developed from the program. But even if the California Program were the subject of the paper, the writer believes that he would be entitled to comment. If Mr. Dewell will refer to the preface of *Special Publication No. 201*, he will note that the writer acted in an advisory capacity on the California Seismological Program. This fact is probably omitted inadvertently in the eight unofficial publications to which Mr. Dewell refers.

Furthermore, it is fair to mention that experimental results such as are given in Figs. 3 and 4 furnish confirmation of principles of structural behavior under dynamic loading, which had been discussed independently by the writer from analytical considerations published in his book, *Dynamics of Earthquake Resistant Structures*, prior to the California Seismological Program, and in papers of record.

With these facts in mind, I believe that a re-reading of the paper, "Buildings Have Pulses," will disclose no intention, on the part of the writer, to claim credit where it is not due—or to withhold it where it is due.

JACOB J. CRESKOFF
Consulting Engineer

Philadelphia, Pa.
October 11, 1937

"Force-Account" Different from "Day-Labor" System

DEAR SIR: May I have space in CIVIL ENGINEERING for an appeal to that small percentage of civil engineers who fail to differentiate between day-labor and force-account methods of carrying on construction and thus perpetuate a deplorable and entirely unnecessary confusion in terminology. Except in direct quotations from other sources, I have never noted this error in contractors' magazines such as *The Constructor* of the Associated General Contractors of America and *The Bulletin* of the General Contractors' Association of New York, though I have been a constant reader of both these magazines for many years.

Force-account is not "a development of the day-labor system," but is distinctly a part of the lump-sum contract system. That is, the term arose on lump-sum contract work when part of the work such as foundations, could not be designed readily in advance and therefore could not be included in the bid. These parts of the work were not "extras," but were foreseen; and it was only natural to designate them force-account work since the engineer was required to keep account of the force of the contractor employed upon them. Thus the effect was really to apply a cost-plus method to parts of a lump-sum contract.

This confusion in terminology can be eliminated very easily if all engineers will restrict the term "force-account" to its original meaning. I am sending this communication in the hope that this desirable purpose may be achieved as quickly as possible, since delay only adds to the confusion.

FRED A. BARNES, M. Am. Soc. C.E.
Professor of Railroad Engineering
Cornell University

Ithaca, N.Y.
September 21, 1937

SOCIETY AFFAIRS

Official and Semi-Official

A Fall Meeting in a Colonial Setting

Boston Plays the Part of the Perfect Host, October 6–8, 1937

BOSTON, under the leadership of the Northeastern Section and with the collaboration of all the other Local Sections in New England, was host to a very successful Fall Meeting of the Society on October 6, 7, and 8, 1937. The local committees had planned an excellent technical program as well as unique social features set against the background of New England's history and tradition. Beautiful autumn foliage and ideal fall weather contributed much to the pleasure of the attending members and guests.

The local committees on arrangements accepted responsibility to an unusual degree and provided a wide assortment of technical meetings, luncheons, conferences, rides, and inspection trips, with all details minutely perfected in advance. Headquarters and meetings were at the Statler Hotel.

ATTENDANCE AS AN INDEX

The registration totaled well over a thousand. Several factors had a part in this fine showing. Foremost among them was probably the interest of the Student Chapters. All those in New England seemed to be represented, and even a Chapter as far away as the Virginia Military Institute had a group present. Many of the colleges excused classes to permit attendance for the first two days of the meeting. The total number of students present was nearly 300.

Then there were Canadian engineers and their ladies in generous numbers. Many provinces were represented, even as far distant as British Columbia, although quite naturally Quebec and Ontario predominated. A number of the national officers of the Engineering Institute of Canada took part in the proceedings, so that this was a joint meeting of the Institute and the Society in fact as well as in name.

AN AUSPICIOUS BEGINNING

At the outset, the quality of the first session set the tempo for the entire meeting. In addition to the Society's representatives, there were six outstanding speakers not members of the Society, and it is an unusual and noteworthy fact that every one of them did the Society the great honor of attending in person. President Desbarats of the Institute, and Acting President Lupfer of the Society, gave a fitting official tone to the meeting. In addition, Governor Hurley of Massachusetts and Mayor Mansfield of Boston made the guests feel that their welcome was genuine. There followed President Conant of Harvard and President Compton of Massachusetts Institute of Technology. Finally, Professor Gropius of Harvard added a technical touch with a lecture on the "New Architecture."

Seldom has such a notable group graced a Society meeting. On a single program were the governor of New England's most populous state and the mayor of its largest city, the president of the oldest college in the country, and the president of one of the oldest and largest technical institutions. The outstanding nature of this combination was fully appreciated by the assembly.

Departing from the usual routine, the official gathering of students began with a luncheon and ended with a single speaker from the Society membership. More than 350 persons sat down to lunch. Scattered among the tables were Society officers, Faculty Advisers, and Contact Members, and outstanding members of the Society. The students were made to feel at home and apparently enjoyed to the limit this opportunity to talk informally with older members of the profession.

Immediately following the luncheon, a brilliant and inspiring address was given by W. T. Chevalier, M. Am. Soc. C.E., who enjoys a reputation for pungent and thought-provoking talks to students and other groups of engineers. Colonel Chevalier advised the students to discover and develop their abilities and then to map their courses toward a worthy goal. Never has he had a more appreciative audience. It was difficult to get the students started from this meeting for the technical sessions scheduled directly afterward.

A special feature of this luncheon deserves mentioning, that is, the provision whereby the students paid only a fraction of the full cost, or an amount approximating their normal outlay. This was just another example of the careful, detailed, and thoughtful planning by the general committee.

CANADIANS CONDUCT AFTERNOON PROGRAM

Important engineering enterprises in the Dominion of Canada held the spotlight in the afternoon. This was the session arranged by the Engineering Institute of Canada and conducted under its auspices. A variety of engineering fields were represented, including foundation work in the west—British Columbia; harbor engineering in the east—Halifax, N.S.; and hydroelectric design in still another province—Quebec.

A plan of procedure was developed by which a Canadian engineer having responsibility for a project introduced the subject by a formal paper. Following him one or more from the Dominion offered discussions. Then American engineers submitted comments resulting from their own study of the paper. Finally, open discussion was invited from the floor. Judging from the interest shown by the audience, which remained in attendance right up to adjournment, the plan was a distinct success.

Although these two sessions on Wednesday were the only ones in which the Canadian visitors had an official share, they were interested listeners at all the meetings that followed. Most of them stayed through the Thursday meetings and the Friday trips as well.

FOUR SESSIONS AT A TIME

A total of eight Technical Division sessions was provided for Thursday, October 7—four in the morning and the same number in the afternoon. Special interest centered in the two parts of the program on Soil Mechanics and Foundations. In part this was due to the excellent subjects and their treatments, and in part also to the fact this was the inaugural of the Division's activities. It

HENRY EARLE RIGGS NOMINATED FOR SOCIETY PRESIDENT FOR 1938

Henry Earle Riggs, of Ann Arbor, Mich., was selected by the Nominating Committee at its meeting in Boston on October 5, 1937, to be the official nominee for President of the Society for 1938. His name, together with those of the official nominees for other Society offices, will appear on the final ballot, to be voted on in January by all Corporate Members in good standing.

Fifty years of achievement have marked Dr. Riggs' professional activities, including 18 years as head of the department of civil engineering at the University of Michigan in addition to an exceptional career in consulting work. Specializing since 1908 in valuation and in the preparation of cases dealing with theories of valuation and depreciation, he has been retained by some of the leading railroads and public utilities in the country on valuation, taxation, and rate-making cases, and is the author of a book and of numerous papers on valuation, depreciation, and allied subjects. The conspicuous service he has rendered to the Society in the past as Director and as Vice-President is fittingly recognized in his nomination for the highest office in the Society.

A more complete biography of Dr. Riggs will appear in a later issue.

was evident that a great deal of effort had gone into special preparation, with the result that the largest meeting room available was comfortably filled throughout the day, while speakers recounted recent applications of this method of analysis to levees, embankments, and building foundations.

In spite of such competition the other Divisions attracted and held large audiences. Surveying procedure in Massachusetts was the general subject in the Surveying and Mapping program, and the sanitary aspects of river and harbor waters in the Sanitary Engineering Division session. Both held morning sessions only. The Engineering-Economics and Finance Division spent the full day, morning and afternoon, in extensive discussion centered about public works. Various phases of this subject were vigorously treated, the burden of the talks reverting persistently to such familiar topics as rational planning, public opinion, and unjustifiable construction.

A single session occupied the attention of the Waterways group. Marine borers and pier construction in Boston Harbor were the topics considered. Rounding out the afternoon program was a single session of the City Planning Division, with two papers dealing with metropolitan regional developments. The four simultaneous meetings were held in adjoining rooms on a single foyer. Nevertheless there was little if any visiting back and forth between the meetings. Perhaps this was because seats were at a premium and it was not safe to give up a comfortable position at an interesting session. In all, about 500 listeners were in continuous attendance. This gives some measure of the popularity of the programs arranged by the Divisions. The December issue of CIVIL ENGINEERING is being reserved for abstracts of these splendid papers, including those given on both Wednesday and Thursday.

In This Issue . . .

What Should the Technical School Teach? (Editorial) . . . . . p. 733
A Fall Meeting in a Colonial Setting . . . . . p. 775
Henry Earle Riggs Nominated for Society President . . . . . p. 775
Society Nominees for 1938 . . . . . p. 777
Board of Direction Meeting—Secretary's Abstract . . . . . p. 776
New Honorary Members . . . . . p. 779
Prize Winners for 1937 . . . . . p. 779
Helpful Hints to Student Chapters . . . . . p. 778
The Student Engineer Looks Ahead . . . . . p. 781
Engineering Curricula Accredited by Engineers' Council . . . . . p. 789
Early Presidents of the Society—William P. Shinn . . . . . p. 786

CONTINUOUS ENTERTAINMENT

It is hardly too broad a statement to make that some form of social gathering was planned for every available moment. As the ladies were better able to take advantage of these events, they were especially favored. The variety of program for them included museum inspections, a motor trip to historic Lexington and Concord, and lunch at the famous Wayside Inn. Those present on Tuesday also enjoyed a splendid luncheon and trip to Plymouth and the Cape Cod Canal.

On Friday the party divided. Some went to see the Cape Cod Canal, and a large group traveled by bus to inspect the extensive works of the Metropolitan District Water Supply Commission. By far the largest number split up into morning parties visiting laboratories at Harvard and at the Massachusetts Institute of Technology, and taking motor trips to Lowell or along the North Shore. All these morning groups converged toward the New Ocean House in Swampscott to enjoy one of New England's famous treats—a shore dinner. This made a fitting conclusion to the Fall Meeting, at which interest so naturally centered around the historic, engineering, and social features of New England.

The evening functions included a vaudeville and musical entertainment on Wednesday followed by dancing and a formal dinner and dance on Thursday.

The dinner was attended by a number of eminent guests, who were seated at a head table along one side of the ballroom. Officers of the Society, of the Institute, of the Northeastern and neighboring Sections, of the American Institute of Architects, of transportation and similar organizations, and of local technical groups lent a pleasing note of engineering sociability and solidarity.

SOME INCIDENTAL PLEASURES

Mention should also be made of two events that were not on the official program. The Board of Direction, convening on Monday, took occasion to show its appreciation of the fine preparations for the meeting by inviting officers of the nearby Local Sections, together with the chairmen of the various committees on arrangements, to lunch. This event, necessarily brief because it had to be fitted in between two Board sessions, was nevertheless delightful.

On the following evening, Tuesday, the Northeastern Section entertained the Board and other visitors with their ladies at a most unique function. It was a dinner held in the famous Faneuil Hall, better known as the "Cradle of Liberty." As a further distinction it was held in the headquarters of the Ancient and Honorable Artillery Company, the first chartered military organization on the North American continent. The dinner itself was in keeping with the circumstances—fish chowder, New England boiled dinner with every vegetable imaginable, and Indian pudding, all supplemented by rum punch. A lecture illustrating the humor of the Colonial period—mostly lost on the Puritans—was the entertainment feature.

A number of committees took advantage of the time and place by holding meetings at Boston. In particular, the Technical Procedure Committee met on Tuesday afternoon with almost a full attendance, including the chairmen of most of the Divisions. Many administrative details of Society organization were discussed and helpful comments offered.

In a meeting that includes such extensive plans for outside events, the weather is an important feature. In this as in other details Boston excelled. A sprinkle on one afternoon was the sum total of the inclement weather.

It was a matter of general comment that arrangements were perfect in every detail. There was not a single observable hitch. Credit for this success could not be accurately fixed—the general chairman asserted it belonged to the subcommittee and the Local Section chairmen, while the latter insisted that the general chairman deserved it all.

However this argument may terminate, the rank and file of the visitors are unanimous in feeling that the meeting was a complete success and that the committee did a perfect job of careful planning and detailed preparation. The Boston meeting will long be considered a model for similar Society events.

Meeting of Board of Direction, October 4 and 5, 1937—Secretary's Abstract

ON OCTOBER 4 and 5, 1937, the Board of Direction met at the Hotel Statler, Boston, Mass., with Vice-President Edward P. Lupfer in the chair, George T. Seabury, Secretary, and the following members of the Board: Messrs. Arneson, Bellinger, Burdick Crawford, Davis, Dean, Dennis, Ferebee, Finch, Gowdy, Hidinger, Hill, Legaré, Leisen, Mead, Morse, Myers, Needles, Poole, Shea, Stabler, Stanton, and Tuttle.

Approval of Minutes

Minutes of the Meeting of the Board held on July 19–20, 1937, were approved.

Horatio Allen Scholarship

Recommendation of the Committee on the Horatio Allen Scholarship (Columbia University) was approved, with award to Cleveland R. Horne, Jr., Jun. Am. Soc. C.E., of Vicksburg, Miss., for the year 1937–1938.

Division Executive Committees

From the suggestions of the Division nominating committees the Board chose one new member for the executive committee of each Division for a term of five years beginning in 1938. The complete list appears on another page.

Appointments

Provision was made for filling vacancies or for new appointments in various Society activities.

Prizes for 1937

Winners of Society and Division prizes for 1937 were selected on committee recommendation. See detailed items in this issue.

New Sections

Receiving application and full details in proper form, the Board approved formation of the Hawaii Section of the Society with headquarters at Honolulu. It also accepted the form of constitution submitted by the new West Virginia Section, whose formation was approved at the Detroit Meeting. Necessary allotments of funds were voted to both these Sections.

By-Laws, Article VII, "Local Sections," Amended

Following prescribed procedure, the Board gave final consideration to and adopted a proposed amendment to the By-Laws, Article VII, entitled "Local Sections," concluding extended study. Wording of the new By-Law with brief comments will be found elsewhere in this issue.

Committee Reports

Various committee and other reports were received, with appropriate action.

The Committee on Professional Activities reported in detail on matters connected with the new provisions for Local Sections. On its recommendation the Board adopted a method for administering Section operations, including the financing of the new plan, and took steps for determining Section boundaries.

Honorary Members Elected

Ballots for Honorary Members were canvassed, resulting in the election of George S. Davison, Otis E. Hovey, Hunter McDonald, and J. R. Worcester. In view of the death of Past-President McDonald during the process of election, the Board decided on an appropriate method of awarding the honor to him posthumously.

Special Guests

By special invitation, officers of the Connecticut, Northeastern, and Providence Local Sections were guests of the Board at its session Monday afternoon, October 4, 1937.

Society Meetings, 1938–1939

The date for the Spring Meeting at Jacksonville, Fla., was fixed as April 20–22, 1938.

After reference to the Tennessee Valley Section, the Board confirmed arrangements for holding the 1939 Spring Meeting at Chattanooga, Tenn.

The date for the 1938 Summer Meeting, already fixed for Salt Lake City, Utah, was discussed. Approval was given for holding this meeting sometime during July 1938, the exact date to be determined later.

Districts and Zones, 1938

Recommendation of the Committee on Districts and Zones was approved, to the effect that no change from the present boundaries be made for 1938.

Hydraulics Division Proposed

A petition was received, signed by a large number of members, requesting the formation of a new Hydraulics Division of the Society, and suggesting a proposed form of constitution. After discussion, this matter was referred to the Committee on Technical Procedure for report.

Topographic Mapping Program

After discussion of the status of topographic mapping, the following resolution was adopted:

"WHEREAS, The Board of Direction, American Society of Civil Engineers, has for many years favored the extension of topographic mapping throughout the United States, and

"WHEREAS, The Secretary of the Interior of the United States has recommended to the Congress a commendable program to expedite topographic mapping;

"*Therefore, Be It Resolved*, That each Local Section be so advised, and

"*Be It Further Resolved*, That this resolution be published promptly in CIVIL ENGINEERING."

Movie Record

The Board made provision for reproducing for Society records a motion picture film of former officers, many of whom have since died.

Routine Matters

A number of matters of routine and record, including those related to election and transfer of members, were also discussed and suitable action taken.

Adjournment

The Board adjourned to meet in connection with the Annual Meeting of the Society at Society Headquarters on January 17, 1938.

Society Nominees for 1938

THE SECOND ballot to determine nominees for Society offices other than president for the year 1938 was canvassed on October 15, 1937. The full report of the tellers on this ballot appears elsewhere in this issue. On October 5, the Nominating Committee chose the candidate for the office of president, in accordance with Article VII, Section 4, of the Constitution. The complete list of nominees follows:

For President:
Henry Earle Riggs, of Ann Arbor, Mich.

For Vice-Presidents:
Zone I, Malcolm Pirnie, of New York, N.Y.
Zone IV, E. N. Noyes, of Dallas, Tex.

For Directors:
District 3, Arthur W. Harrington, of Albany, N.Y.
District 5, James A. Anderson, of Lexington, Va.
District 7, Louis E. Ayres, of Ann Arbor, Mich.
District 8, W. W. DeBerard, of Chicago, Ill.
District 9, Joseph E. Root, of Cincinnati, Ohio
District 12, Ross K. Tiffany, of Olympia, Wash.
District 16, Thomas R. Agg, of Ames, Iowa

These nominees will be voted on by the use of final ballots sent to every Corporate Member forty days before the Annual Meeting in January. One week before the Meeting the ballots will be canvassed, and the elected officers will be inducted into office at the Meeting.

New Appointees to Division Executive Committees

MEMBERSHIP on the executive committees of the Technical Divisions is progressive; each year one member retires and a new one is appointed for a five-year term. The machinery as stated in the By-Laws provides for selection by a nominating committee in each Division and appointment from the nominees by the Board of Direction.

Following this routine, new members for the Division executive committees were selected by the Board at its Boston Meeting, October 4, 1937, as follows:

DIVISION	NOMINEE
City Planning	C. A. Farwell
Construction	John W. Cowper
Engineering-Economics and Finance	E. B. Black
Highway	R. W. Crum
Irrigation	S. T. Harding
Power	Harrison G. Roby
Sanitary Engineering	Linn H. Enslow
Soil Mechanics and Foundations	William P. Creager
Structural	Allston Dana
Surveying and Mapping	William Bowie
Waterways	E. L. Daley

Helpful Hints to Student Chapters

With Interesting Details of Last Year's Activities at Three Colleges

By HUNTER W. HANLY, M. AM. SOC. C.E.

CHAIRMAN, COMMITTEE ON STUDENT CHAPTERS; STRUCTURAL ENGINEER, CINCINNATI, OHIO

IT HAS BEEN the policy of the Committee on Student Chapters to leave the greatest of freedom to Student Chapters in the organization and conduct of their affairs, but a request for guidance comes so frequently from Chapters which, for one reason or another, feel that they are not getting out of their existence what they might or should, that the committee is disposed to offer for their consideration some examples of excellent details that have come to the surface in the last few years.

One Chapter naïvely asked, "What is necessary to be done to win one of the President's letters of commendation for merit?" The answer would obviously be, "Do something meritorious." The limitations of geographical location, size of membership, distance to engineering groups and operations outside of schools, and many such things, all conspire to make more difficult the accomplishment of something really meritorious. Possibly upon a suggestion as to what the other fellow is doing may hinge the necessary inspiration for overcoming the obstacles confronting the Chapter.

In the first place, a Chapter anywhere must be organized with definite duties, taken seriously by capable officers, before much can be accomplished. A very fine setup presenting this phase of the picture comes from correspondence with Prof. J. J. Doland, Faculty Adviser at the University of Illinois.

"We utilize this Chapter to serve as a training ground, during the four years the student is in college, to teach the student how to become a valuable member of a professional society and to develop executive ability in those students who display an active interest in the first two years. To do this we have a rather elaborate committee system which provides a job for all who desire to work for the Chapter. As a result the Chapter officers (who are seniors) have had considerable experience in the Chapter affairs by the time they assume office. We thus maintain a continuity over the short tenure of student generations which makes for very smooth and effective operation.

"Our membership fee for freshmen (associate members of the Chapter) is 50 cents per year, of which the Central Illinois Section pays one-half. All others pay one dollar with no subsidy. We thus attract the freshmen, make them members and put them, or some of them, to work. It is therefore not difficult to interest the sophomores at one dollar. We feel, however, that the dues charged are as high as the traffic will bear since the majority of our students are not wealthy.

"The University of Illinois Chapter maintains an office in the Engineering Building. They operate on a yearly budget of about $200 and need most of it for printing, entertainment of speakers, trips to conferences, smokers, holiday greetings, and other items. Incidentally, this also permits of training in good manners and courtesy. Accumulated savings from the budget are spent for office furniture, stenographic help, etc. The officers advised me a few moments ago that the Chapter had appropriated $50 for furniture."

The content of Chapter programs must depend pretty largely on the availability of good speakers on appropriate subjects, on the proximity of engineering operations which will be both interesting and enlightening, and upon the thoughtfulness and resourcefulness of program chairmen in taking care of the situation when strictly local material must be used. The secretary of the Chapter at the University of Colorado, James Scott, has sent the following program of their year's meetings (subjects marked with an asterisk were presented by students):

PROGRAM FOR THE YEAR 1936–1937

October 7	Summer Experiences* (by five students)
October 21	Soil Erosion
October 28	Colorado Engineers' Apple Fest
November 4	Tree Rings and Rainfall
November 18	Pittsburgh's Liberty Tunnels* The Quebec Bridge* The Bernoulli Family*
December 2	The Madden Dam* Modern Tendencies in Architecture* The Proposed Nicaraguan Canal*
January 6	Alloy Steels and Their Use in Structures* Air Conditioning and Architecture* New World Architecture*
January 20	Los Angeles Water Supply* Buildings and Construction from Ancient to Modern Times*
January 27	Joint Meeting with University of Colorado Student Section, American Institute of Chemical Engineers
February 3	Famous Monuments of the World* The Cape to Cairo Railroad* Buildings of the 1933 Chicago World's Fair*
February 17	The Engineer and the Contractor
March 3	Modern Highway Construction* The Grand Coulee Project* Brick Masonry*
April 7	The Sewage Disposal Plant at Denver
April 21	The Bay Bridge at San Francisco* Transmountain Diversion of Water* The Caddoa Dam*
May 5	The Fort Peck Project* Some Bridges of New York City* The Goodyear Hangar at Akron, Ohio*
May 10	Inspection Trip and Joint Meeting, Colorado Section American Society of Civil Engineers, Denver, Colo.
May 19	The Civil Engineer in the Canal Zone

It should be noted that this program was prepared completely at the beginning of the year, and that most of the papers were presented by students.

Programs like this from Colorado and organizations like the Illinois Chapter might be set up and would be effective toward some desirable end, but the objective in all of this enterprise includes an understanding appreciation of, and an interest in, the American Society of Civil Engineers. It is hardly necessary to state that the Society is deeply interested in its Chapters. Faculty members charged with the supervision of Chapter activities within the schools are required to be connected with the American Society of Civil Engineers, and can be depended upon to present the ideals of the Society in their contact with the students.

Operations would fall far short of the goal, however, if the membership of the Society did not come into close contact with the Chapter in whatever capacity and frequency may be possible. It is for the establishment and maintenance of this more extensive intimacy that the Contact Member for a Chapter is appointed. Naturally, his effectiveness and his interest will depend upon his application to the situation, his reception by the Faculty Adviser and the Chapter, and the extent to which the Chapter officers ask and get his cooperation.

The Chapter at Kansas State College presents a very excellent picture of such a relation between Faculty Adviser and Contact Member. The following extracts from a letter from Prof. M. W. Furr, Faculty Adviser, and the answer from Mr. W. E. Baldry, Contact Member, display the type of cooperation that produces results. From Prof. Furr:

"I thought that you would be interested to know something of our plans for this school year. We have a good enrolment in the Chapter which, as you know, is operated on the basis of required attendance. There are 20 Seniors, 59 Juniors, and 57 Sophomores enrolled. We do not make the same requirements for Sophomores as we make for Juniors and Seniors, which means that our Chapter consists primarily of the upper classes in civil engineering. We have already held two meetings and a good general interest was shown."

There follows a list of Chapter officers and an announcement of the next meeting. Then,

"I work with all of the officers and students in an ex officio capacity. Also, I make it a point to attend all of the meetings. One thing, too, that is pleasing to me here at Kansas State is that most of the faculty members of this department make it a point to attend all meetings—of course this impresses the students.

We usually hold our meetings on the first and third Thursdays of each month at four o'clock p.m. We would be pleased to have you visit us at any time, and I think the program committee has in mind to include you as principal speaker on one of the programs soon. We hope that you will be able to be with us on such an occasion and to pay us a visit at any convenient time."

Mr. Baldry's reply was, in part:

"I have read your letter with interest, and am much pleased with your Chapter activities. The pamphlet reports of Chapter activities distributed to us from time to time show the splendid interest our Chapter takes in Society affairs."

Mr. Baldry continued by stating his belief that the contact member should assist in bringing before the students outside speakers to present topics of general interest outside the range of their scholastic work, and concluded:

"I am accepting the suggestion in your letter that the writer appear as principal speaker on one of your coming programs. I will endeavor to fulfill whatever date the program committee may select for me."

The excellent details presented in the above picture of Chapter activities come from a devotion that contributes generously of hard work, clear thought, and keen interest on the part of all charged with the conduct of the Chapter. The Committee on Student Chapters offers these as examples of what may be done to make the Chapter interesting and beneficial to the students. These are not isolated examples of excellence, for a large number of Chapters are producing fine results along similar lines. The variations from these examples are limited only by the ingenuity and tastes of the Chapters involved.

Four New Honorary Members

FOLLOWING the routine prescribed in the Constitution, the list of Honorary Members was augmented by vote of the Board of Direction on October 4, 1937, by the addition of George S. Davison of Pittsburgh, Pa.; Otis E. Hovey of New York, N.Y.; Hunter McDonald of Nashville, Tenn. (posthumously); and J. R. Worcester, of Boston, Mass.

All are well known in the profession. Mr. Davison, a Past-President of the Society, was formerly vice-president of the Gulf Oil Corporation and is now president of the Davison Coke and Iron Company. Mr. Hovey recently retired as assistant chief engineer of the American Bridge Company; for many years he has been treasurer of the Society. Mr. McDonald, also a Past-President, had had a long term of service as chief engineer of the Nashville, Chattanooga and St. Louis Railroad. He died before the results of the election were determined. Mr. Worcester, a member of the Society for more than forty years, is widely known for a lifetime of important consulting practice, with headquarters in Boston.

A more extensive record of these eminent engineers will be presented later in these pages.

Rudolph Hering Medal Awarded

LIKE OTHER prize awards in the Society, the Rudolph Hering Medal is given for successful authorship in a special field. Unlike the others, however, its management is under the Sanitary Engineering Division rather than the Board of Direction representing the Society as a whole. Accordingly, recommendation originates from a committee of the Division and thence goes to the Board for approval.

Following this plan, the Board on October 4, 1937, confirmed the award for the current year to W. W. Horner, M. Am. Soc. C.E., and F. L. Flynt, Assoc. M. Am. Soc. C.E., for their joint paper entitled "Relation Between Rainfall and Runoff from Small Urban Areas." This paper, numbered 1926, will be found in the 1936 TRANSACTIONS, Vol. 101. The ceremony of award, with others for the same period, will take place at the Annual Meeting, January 19-21, 1938.

Director C. Arthur Poole

MEMBERS OF THE Society were shocked by the sudden death of C. Arthur Poole, Director of the Society and resident engineer-inspector for the Federal Emergency Administration of Public Works, which occurred at his home in Niagara Falls, N.Y., on October 14, 1937. Mr. Poole was born in Rochester, N.Y., on June 23, 1874, and was graduated from Princeton University in 1895 with the degree of C.E. Following his graduation, he was employed for several years in the office of the state engineer and surveyor of New York during the improvement of the old Erie Canal. From 1899 to 1904 he was engaged largely in railroad work, serving in various capacities both on location and construction. During this period he was with the New York Central Railroad for a year and a half and spent about two years in Norway, where he was engaged in the construction of a railroad, harbor, and docks.

In 1904 he returned to the New York State Department of Engineering, where he remained until 1909. This was during the construction of the New York State Barge Canal. He served as assistant engineer on the preliminary work and was resident engineer of construction for two years, having his headquarters at Waterford, N.Y. From 1910 to 1911, he was engineer for the Ferguson Contracting Company, with offices in New York City.

In the spring of 1911, Mr. Poole returned to Rochester and began a 23-year period of almost continuous service with the city. For six years he was in charge of the design and construction of a new sewage system and disposal works. In 1918 he became city engineer. In 1928 he was appointed consulting engineer to the city, and in 1932, city manager. In 1933 he again became city engineer. He retired from this position in February 1934 but continued as consulting engineer to the city until 1935. From then until his death he served as resident engineer-inspector for the Federal Emergency Administration of Public Works, Niagara Falls, N.Y.

During the World War he was a captain in the Corps of Engineers, U. S. Army, being assigned to the 150th Engineers.

In addition to Mr. Poole's long and active affiliation with the Rochester Section of the Society, of which he served as president, he was active in the work of other professional societies. He was a member and former president of the American Society of Municipal Engineers; a member and former director of the American Association of Engineers; a member and former president of the Rochester Engineering Society; and a member of the Princeton Engineering Association, the American Water Works Association, and the American Society of Military Engineers.

Mr. Poole had been a member of the Society for many years. In 1907 he was elected Associate Member, and in 1921 Member. His term as Director from District 3 began in January 1935 and would have expired in January 1938.

Prize Winners for 1937

ACTING upon the recommendations of its Committee on Prizes, the Board of Direction meeting in Boston, October 4, 1937, completed the official selection of prize winners for the current year. All the awards are made for papers appearing in Volume 101 (1936) of TRANSACTIONS. The following are the authors, with the papers for which the various prizes are bestowed:

The Norman Medal for "The Silt Problem" (Paper No. 1927), by J. C. Stevens, M. Am. Soc. C.E.

The J. James R. Croes Medal for "Structural Beams in Torsion" (Paper No. 1941), by Inge Lyse, M. Am. Soc. C.E., and Bruce G. Johnston, Jun. Am. Soc. C.E.

The Thomas Fitch Rowland Prize for "The Springwells Filtration Plant, Detroit, Michigan" (Paper No. 1929), by Eugene A. Hardin, M. Am. Soc. C.E.

The James Laurie Prize for "The Hydraulic Jump in Terms of Dynamic Similarity" (Paper No. 1935), by Boris A. Bakhmeteff, M. Am. Soc. C.E., and Arthur E. Matzke, Jun. Am. Soc. C.E.

The Arthur M. Wellington Prize for "Proposed Improvement of the Cape Cod Canal" (Paper No. 1953), by Capt. E. C. Harwood, Corps of Engineers, U. S. Army, Boston, Mass.

The Collingwood Prize for Juniors for "Frictional Resistance in Artificially Roughened Pipes" (Paper No. 1936), by Victor L. Streeter, Jun. Am. Soc. C.E.

Fitting ceremonies for presenting these high honors will be part of the program of the Society's Annual Meeting in January 1938.

Local Sections Enlarged

Important Changes Effected by Revision of Society By-Laws

AFTER EXTENSIVE study by Society committees and Local Sections and discussion in its own meetings, the Board of Direction on October 5, 1937, revised the Society By-Laws in respect to affairs of Local Sections. The new provisions are embodied in the changes in Article VII, "Local Sections," which as amended reads:

"(1) The territory occupied by the membership in North America shall be divided into Local Section Areas, and Local Section Areas may be formed outside of North America. On or before April 1 of each year the Board of Direction shall review the existing divisions and if necessary make changes in their boundaries. Each Local Section Area shall be formed with due regard to mutuality of interest and facilities of travel and shall embrace the normal zone of influence of the Local Section; and each Local Section whose Area would be affected thereby shall first be given opportunity to be heard.

"(2) A Local Section may be authorized by the Board of Direction, at the written request of fifteen Corporate Members of the Society, provided that at least twenty-five members of all grades reside within the Local Section Area to be formed.

"(3) All members of all grades whose addresses, as defined in Article VII of the Constitution, are within a Local Section Area shall be deemed to belong to the Local Section serving such Area, provided that a member who does not subscribe to the Constitution and By-Laws of said Section shall have no voice nor part in the government of the Section.

"(4) The Constitution and By-Laws of a Local Section and all amendments thereto must be approved by the Board of Direction before becoming effective.

"(5) The Board of Direction shall assign to each Local Section from the funds of the Society in January of each year a sum equal to $50.00 plus $1.50 for each member deemed to belong to the Section and plus an amount equal to the regular dues collected by the Section in its fiscal year next preceding, all within the limit set forth in Article IX of the Constitution and subject to such further restrictions as the Board of Direction may from time to time make uniformly applicable."

The first step towards initiating this plan is for each Section to redefine the boundaries of its area of influence, after consultation with adjacent Sections, so that boundaries will be mutually acceptable and contiguous where practicable. As soon as boundaries have been approved by the Board of Direction, which will take action on the matter at its January 1938 meeting, the secretary of each Section will be furnished with a mailing list of all members belonging to his Section.

This plan for the allocation of every member to a Local Section was outlined briefly in the September 1937 issue of CIVIL ENGINEERING, page 651. It was recognized in developing the plan that the allocation of a member by the Board to a particular Section could not carry with it the obligation for that member to pay Local Section dues or subscribe to the constitution of the Section to which he was allocated. Doubtless, however, most members will be glad to fulfill these reasonable provisions and by so doing gain the privilege of sharing in all of the Section activities.

This should result in mutual advantage to the member himself and to the Section. He will gain the more active association with his fellow members, to his professional as well as his social advantage. He will be brought into closer contact with the Society work and especially with the efforts of the Local Section in his own area. This should broaden him and make him a more valuable engineer.

To the Section the gain is likewise definite. Increase in membership, and with this the increase in funds, will widen the Section's scope. Its influence locally will be greater. The efforts of its members in community affairs will be augmented by the weight of added numbers. New members will bring new personalities, new ideas, and new vitality.

In a word, the enlarged Local Section, if it fulfills in reasonable measure the hopes of its advocates, will strengthen the Society both as to the individual and in the mass.

Tellers Report on Second Ballot for Official Nominees

To the Secretary
American Society of Civil Engineers: *October 15, 1937*

The tellers appointed to canvass the Second Ballot for Official Nominees report as follows:

Total number of ballots received	2,764
Excluded ballots:	
From members in arrears of dues	74
Not signed	16
With printed signature	1
Total ballots withheld from canvass	91
Ballots canvassed	2,673

For Vice-President, Zone I

Malcolm Pirnie	848
Void	2
Total	850

For Vice-President, Zone IV

E. N. Noyes	650
Void	11
Blank	14
Total	675

For Director, District 3

Arthur W. Harrington	132
Roy G. Finch	97
Void	16
Blank	3
Total	248

For Director, District 5

James A. Anderson	164
Void	1
Total	165

For Director, District 7

Louis E. Ayres	230
Total	230

For Director, District 8

W. W. DeBerard	143
Wilbur M. Wilson	68
Total	211

For Director, District 9

Wendell P. Brown	116
Joseph E. Root	172
Total	288

For Director, District 12

Ross K. Tiffany	121
Blank	1
Total	122

For Director, District 16

Thomas R. Agg	150
Lowell E. Conrad	103
Void	1
Total	254

Respectfully submitted,

DEAN G. EDWARDS, *Chairman*

Medwin Matthews
Robert G. Waggener
Thomas K. A. Hendrick
Theodore F. Weiss
Charles W. Comstock
Malcolm S. Spelman
Frederick C. Lowy
Joseph Fertik
A. A. Dedouloff
Tellers

The Engineer Looks Ahead

Excerpts from an Address to Students—and to Young Engineers—on the Demands and Opportunities of the Profession

By E. R. NEEDLES, M. AM. SOC. C.E.
ASH-HOWARD-NEEDLES AND TAMMEN, CONSULTING ENGINEERS, NEW YORK, N.Y.

This address was originally presented at the Regional Conference of Student Chapters held at San Antonio, Tex., in April 1937.

THE Student Chapter movement is one of the finest developments in our professional history. I like to see a young man consider himself as entering the profession of engineering when he enters the college of engineering. We can begin to think professionally as students. I look forward to the day when all engineers, young and old, will have an attitude toward themselves, toward each other, and toward their neighbors, which will embody professional living and ethics so distinctively and attractively that our fellow men will be pleased with us, and will gladly honor us as a group. To deserve that greater appreciation as a group, we must deserve it as individuals.

The college student of today has come into a dramatic existence. The prosperity bubble of the New Era in 1928 and 1929 found him probably too young to know just what boom years meant, and so in another ten years he will probably have to indulge himself in a little boom of his own. But this young man has known the depression in all its bitterness. He has seen the New Deal, government by alphabet, relief, the growth of bureaucracy, the new labor movement, the growth of class consciousness, the Supreme Court contest, and the slow improvement in business. He is seeing grave complications arise to threaten international peace.

SECURITY MUST BE EARNED

In these days of extravagant propaganda, it is difficult to think in an orderly manner and to exercise calm judgment. There are opportunists who contend that youth today is not receiving fair treatment. They demand that youth be guaranteed "steady employment at adequate wages." They demand many things, regardless of effort or merit on the part of those who are to receive these things. In short, they say that "the world owes you a living."

The other day I saw the letter of a young man who will graduate from an engineering college this coming June, in which he stated that he wanted to obtain a position in which he could obtain the greatest security. We all understand that great desire. Well, where do we find security? In money? There are many thousands who discovered again in 1929 that wealth is a fleeting thing. Is there security in what the government may do for us? Ask the politician who is no longer in office. Is there security in what a corporation may do for us? The average corporation is not noted for benevolence and is affected very quickly by any change in the business cycle. Is there security in what a labor union may do for us? Ask the man who is a member of the wrong union, or one who has been exploited by a self-seeking labor leader. Is there security in the provisions which our loved ones may make for us? Ask the widows and orphans. Is there security in socialism, in communism, or in fascism? Ask the socialist, the communist, or the fascist what he thinks about the other two.

Where do we find security, and especially security for the individual? The fellow who said that "all life is a gamble" had pretty good evidence to support his statemnt. But I could never be a pessimist. I have a very definite idea that security lies first with the individual himself. If a man be honest and truly God-fearing and make the most of his talents, whatever they may be, I believe that man will always stand an excellent chance of being well employed. And as we have a constantly more enlightened society which continues to demand a truly democratic form of government reflecting the majority opinion of its people, with due respect for its minorities, I believe that the best interests of the worthy individual will become steadily more secure. This philosophy is very simple. The best thing society or government can afford us is not the questionable security of a regimented life, but the possibility of opportunity, in which we can work our way as reasonably free men and free spirits.

You are becoming members of one of the oldest professions, going back to the days when man first began to build things. As the rulers and people of old became anxious to extend their small empires and their influence, so that they might have greater wealth and more comforts and useful things, their armies moved forward and new countries were developed, with the engineer to provide new roads and bridges, new water supplies, new means of transportation. As new continents were discovered and new trade routes established new cities grew up to require water, streets, and sanitary features, and the engineer became a necessary part of civil life and of trade and transportation.

After the harnessing of steam, came the mechanical engineer. As lightning and thunder ceased to be such mysteries, came the electrical engineer. As the precious and useful metals and ores became more essential to life and industry, came the mining engineer and the metallurgist. As industry and science were wed, the chemical engineer produced his modern magic.

Engineering plays a greater part in life today than ever before. Business and industry demand well-educated men for the important positions. A college education is almost indispensable, and I believe that the engineering course is the most practical course of all, even for those who believe themselves better suited for business than for strictly engineering work. Business and industry are now so closely allied with the sciences that a general knowledge of mathematics, chemistry, and physics may be considered almost as fundamental as the three "R's" were for grandfather.

The graduate civil engineer may choose to become a contractor and builder, he may enter the business of producing and selling engineering materials and supplies, or he may enter the practice of pure engineering. If one is to follow civil engineering in its purest sense, that is, as one who makes the designs and plans and then supervises the actual construction, he must be prepared to learn the more simple jobs first, and to learn them well. There are many to whom surveying and mechanical drawing have been simple drudgery. It is unfortunate when one cannot see beyond the drawing board. I ask you to become a neat, careful, and proud workman with the lettering pen, for that is the tool we use to make a record of our thoughts and plans so that others can build and bring into reality our dreams and mental images. I ask you to become careful, exact, and expert with the surveying instruments. These are the tools with which we fix property lines, locate a structure on the ground, and make certain that all parts are to fit together in proper order. I ask you to know the fundamentals of your mathematics, and to be orderly and precise in your calculations. This is the tool with which we secure the strength of a bridge, the cost of a dam, the safety of our people. Mathematics is the base of all engineering and science. If you cannot use these tools with real interest and satisfaction, it is possible that you are not enough of a dreamer and idealist to enjoy engineering. The engineer is practical—at times he must be intensely practical—but you may be sure that engineering provides plenty of room also for imagination, dreaming, and idealism of the highest order.

APPRAISING ONE'S OWN QUALIFICATIONS

In thinking about the work he is to do after graduation, the young engineer must appraise his own qualifications and try to determine the type of work to which he may become adjusted most readily. Where does his greatest interest lie? In what kind of work will he be happiest? All of us want to make money in a reasonable degree, but if you have a choice, do not take just any job simply because it offers the best starting salary. If you have no choice, take the job available and work at it the best you know how. But keep your eyes open, continue to study yourself, and if later you find an opening in a field which should prove happier, do not hesitate to change jobs, even at a lower salary. But when you change jobs, do so with fairness to both employers.

As you analyze yourself, you may be asking yourself questions. Am I qualified by nature and equipped mentally to answer the high

calling of teaching? Am I equipped to undertake pure research or design, and would I be happy in such endeavor? Would I fit into the construction industry as a builder, a handler of men, materials, and equipment? Am I best suited for industry? And if so, am I interested in production, in the distribution of products, in the sale of products?

You may be asking other questions. Do I prefer to get located near my home, or am I ready to go to a new city or land where I must lay new foundations and cultivate new friends? Would I prefer employment with a smaller, private organization, or does corporation work attract my interest? Or would I be pleased to become a public servant, the employee of a city, a county, a state, or the federal government?

WHAT THE EMPLOYER WANTS

The prospective employer will be anxious to know about you, and he will want to know first if you are honest. He will not expect you to be slick or too clever. He will want to know the kind of a student you have been. He will expect you to have and to maintain reasonably good health. He will wonder if you have some self-assurance and complete self-respect; and if you are respectful of others. He will try to find out how well equipped you are mentally, and if you are ambitious and have initiative and energy. He will wonder if you are agreeable, pleasant, and friendly, if you will prove dependable and loyal, and if you know how to cooperate with your fellows. He will wonder how well you will apply yourself to your job, and how much you will profit from experience. He will not expect you to be an experienced and fast workman; but he will wonder how fast you will learn as a practicing engineer.

The good qualities the employer hopes to find in you are not unattainable. They are simply the usual qualities which you yourself desire to find in those in whom you may wish to place confidence, such as your doctor, your lawyer, or your merchant. If, in addition to possessing these qualities, you show particular aptitude for your work, if you can show a little imagination and originality, a little leadership, a little personality, a little common sense and judgment, I am confident you will not have to worry about progress. You will find yourself receiving increasing responsibilities. All the employers I know are constantly, even in times of depression, looking for the man who is able to assume and successfully handle responsibilities.

When you seek your job, do not hesitate to put your best foot forward. Have the confidence in yourself borne of a determination to make good. Speak as well for yourself as you can. Be polite, but courageous.

It is one thing to get a job, another to do it. You must measure up to your job. It always helps very materially when we have friends to look out for us. But first of all, we must be competent engineers, and demonstrate it by our service. A job well done is the best possible recommendation for a bigger and better one.

THE JOB OF SELF-IMPROVEMENT

There is one job an engineer should undertake in his spare time, for which he cannot receive a salary. This is the job of self-improvement. First, endeavor to continue and extend your technical studies. Seek to read broadly and be informed and cultured. Work at meeting people and making friends and deserving them. Improve your speech. Broaden your understanding of economics and business. Join and become active in your national engineering society. Try to live so that your associates will understand that you are a professional man. Be a part of your community and become interested in its affairs as well as in national affairs.

I do not ask you to become a politician, nor do I believe that our profession is suffering greatly because its members do not seek and hold political office. If you have a flair for politics and think you would be happy in that field, I am sure your sound engineering education will help your judgment and understanding. But there are ethics associated with engineering which are not exactly or always compatible with practical politics. It is my opinion that the public does not expect the engineer to be a politician; and I am sure that the politicians expect him to remain an engineer. I do not complain if the engineer is not a statesman.

Our profession must always be seeking new jobs, new things to do in behalf of our fellow man. Who knows what science and engineering will provide in the future? Who knows about the future of air conditioning; the production of food stuffs; the disposal of waste; travel by air; land and water transportation; new metals and alloys and other new materials which are lighter, stronger, and more permanent; the possibilities in welding metals; the use of buried express highways in our cities; the future sources of power and the transmission of power; new machines; all the new ways of doing old things? The answers to these and thousands of other questions will come from such as you.

There is romance in civil engineering. The bridge which spans the mighty Hudson; the canal across Panama; the dam which curbs the turbulent Colorado; the subway train rushing through the blackness beneath our city streets; the tunnel carrying streams of motor cars, or railway trains, or clearest mountain water, deep beneath our rivers—do these not grip your imagination? Is there not romance in the planning and building of these? Yes, romance, and beauty, and service to man; but also work and more work, and finally the great thrill of accomplishment.

There is adventure in civil engineering. Fighting a river in flood to prevent the results of a year's work from being destroyed overnight; sticking steel out into the air, piece from piece, to meet other steel which is building toward you across the water; a party of surveyors, threading the line of a future highway around the nose of a cliff; joining the sand hogs in the caisson deep in the river bed to know that the bedrock is sound and worthy as a foundation; working quietly but swiftly over the drafting table, all the night through, so that plans for emergency repairs may be ready at daybreak—are not these the elements of real adventure?

A PROFESSION WITH OPPORTUNITIES

There is opportunity in civil engineering, more than ever before. The more people in our nation, the greater the opportunity for service; even as the competition is more severe. As the competition is more severe, the better you must be prepared if you wish to make progress. If you seek the easy job; if you rely on luck alone to bring you wealth and comfort; if you are easily satisfied, easily discouraged, quickly discontented, we may well agree that opportunity for you is limited.

Did you ever see Babe Ruth play baseball? Why was he a star? Natural ability? Yes, in part, but coupled with it in an intense love of the game, a determination to play the game for all he was worth, to give all he had.

If you receive pleasure from a job well done; if you love to do things that are worth while; if you are ambitious and have integrity and courage; if you know what loyalty is and know how to be a true friend; if you have common sense, a fair mind, a good heart, and a willingness to work; there is plenty of opportunity ahead for you. Industry and business cannot exist without you. The nation needs you always, and your reward will be real.

Committee for Standardization of Engineering Practices in Ohio

A COMMITTEE appointed by a group of professional engineers in Ohio, including members of the Cleveland Section of the American Society of Civil Engineers, has prepared a schedule of minimum fees for general engineering services, and more recently, a schedule of surveying fees and a standard form of agreement between owner and engineer. These schedules, which are complete and detailed, have been approved and adopted officially by the Ohio Society of Professional Engineers, the Cleveland Society of Professional Engineers, and the Cleveland Engineering Society. The Committee on Professional Practices of the Cleveland Section of the Society, under the chairmanship of Frank Tolles, M. Am. Soc. C.E., has approved the earlier schedules and is considering the more recent schedules and revisions.

The Committee on the Standardization of Engineering Fees in Ohio is under the active chairmanship of Wendell P. Brown, M. Am. Soc. C.E. Appointed in 1934, it is composed of chairmen of eight divisions, each representing a different section of the state. The divisions meet separately in their own areas, but cooperate directly with, and report to, the state committee through the division chairman.

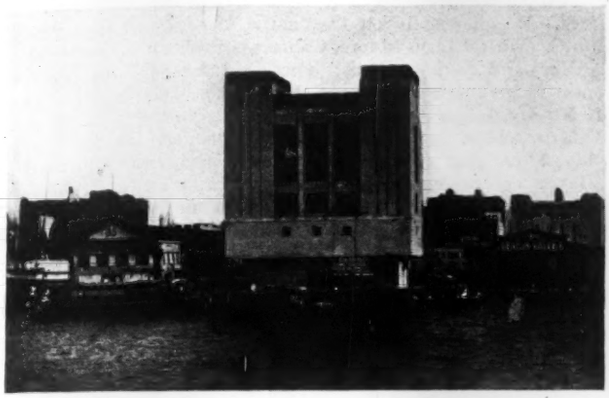
At the present time the committee is considering standardization of practices for engineering services in building construction, and in mechanical and electrical engineering. A special subcommittee is studying the subject of engineers' salaries. As the schedules are completed they will be published in pamphlet form and will be

available to the public as well as to engineers. Those already issued may be secured from the Ohio Society of Professional Engineers, Neil House, Columbus, Ohio, for 5 cents each or $3 per hundred.

The material for this item was supplied by R. G. Harley, Jun. Am. Soc. C.E., junior correspondent for CIVIL ENGINEERING with the Cleveland Section of the Society.

Lantern Lectures Available for Student Chapters

ANNOUNCEMENT was made on September 29, 1937, of the material available for the use of Student Chapters in the form of lantern slides, with mimeographed descriptions, covering a number of important engineering projects. These slides will be sent also to



VENTILATION BUILDING FOR THE HOLLAND TUNNEL, NEW YORK
A Slide from One of the Lantern Lectures

Local Sections or other interested groups, in so far as this does not interfere with previous reservations by the Chapters.

There are now 18 different lectures ready to be sent to any Chapter upon request. The material should be in hand several days before it is to be shown, so that the person responsible for the showing can become familiar with it, and can expand the descriptions from his own study of the subject.

The titles now ready are as follows:

LECTURES	NO. OF SLIDES
Aerial Photographic Mapping	59
Carquinez Strait Bridge	58
Cascade Tunnel	45
Catskill Water Supply	60
Conowingo Hydroelectric Development	46
Coolidge Dam	57
Florianapolis Bridge	36
George Washington Bridge	74
Hetch Hetchy Water Supply and Power Plant	65
Holland Tunnel	58
Joe Wheeler Dam (Tennessee Valley)	48
Miami Flood Control	53
Mississippi Flood Control	60
Norris Dam (Tennessee Valley)	66
Recent Power Development at Niagara Falls	34
San Francisco–Oakland Bay Bridge, Substructure	30
Westchester County Park System	38
Wilson Dam at Muscle Shoals	47

The Society also has available two motion picture films, of the standard 35-mm size. One of these is a two-reel film, of the Stevenson Creek Dam, and the other, of three reels, shows a number of informal pictures of former officers of the Society.

Reservations, for both slides and films, should be made well in advance of the date when they are to be shown. Experience has proved that those who wait until the last minute are often unable to obtain the particular lecture they desire.

Ballot on Constitutional Revisions

Report of Tellers as Announced at Fall Meeting, Boston, Mass., October 6, 1937

October 6, 1937

To the Secretary American Society of Civil Engineers:

The tellers appointed to canvass the Ballot on Amendments to the Constitution report as follows:

Total number of ballots received		3,432
Ballots excluded from the canvass		
From members in arrears of dues	115	
Without signature	14	
Total ballots not canvassed		129
Ballots canvassed		3,303
Proposal No. 1		
Yes		852
No		2,439
Blank		12
Void		0
Total		3,303
Total votes counted on Proposal No. 1 (yes or no)		3,303
Required to carry		2,202
Lost by		1,350
Proposal No. 2		
Yes		912
No		2,382
Blank		9
Void		0
Total		3,303
Total votes counted on Proposal No. 2 (yes or no)		3,303
Required to carry		2,202
Lost by		1,290
Proposal No. 3		
Yes		1,027
No		2,263
Blank		13
Void		0
Total		3,303
Total votes counted on Proposal No. 3 (yes or no)		3,303
Required to carry		2,202
Lost by		1,175

Respectfully submitted,

STANLEY M. DORE, *Chairman*

Charles L. Coburn — Bayard F. Snow
Frank L. Flook — Howard J. Williams
Harvey B. Williams

Tellers

Time to Order Society Badges

AT THIS WRITING Christmas seems a long way off, but actually it is already time to begin thinking about gifts that must be made to order, such as Society badges. No doubt there are a number of members who either have lost their badges or have never had any. Of course no member may have more than one badge at a time, and if the badge has been lost, a brief statement to that effect should accompany the order.

The badge for Corporate Members and Affiliates is a rich shade of blue enamel on solid 14-carat gold, which shows in the lettering and in the border. This costs $5.00, including engraving with the member's name and Society grade. The badge for Juniors, which costs $2.00, is of 8-carat gold, of similar shape and design except that it has a white border. The badge for members of Student Chapters ($1.00) is gold filled. It has a white border like the Junior badge and is maroon where the other badges are blue. Junior and student pins are not engraved. Badges may be had in the form of pins and fobs or charms for watch chains. The pins have safety catches.

Orders should be placed through Society Headquarters 33 West 39th Street, New York, N.Y., not later than December 1 if delivery is required before Christmas.

Prizes by Local Sections to Outstanding Students

Bases of Award; Recipients of Prizes for 1937

DURING the past commencement season many Local Sections followed their usual custom of presenting awards to outstanding members of Student Chapters graduating from schools in their vicinity. The basis of the award, the method of selecting the winner, and the nature and amount of the prize, all vary considerably. In the following paragraphs these details are given, so far as they are available, together with the names of all prize-winners for 1937 that have been reported up to the time of going to press.

In some cases, it will be noted, the prize includes one year's dues. As the first year's dues are remitted to men applying within two months of graduation, such a prize covers the dues for the second year of membership. Attention should also be called to the fact that the election of these men to the grade of Junior depends, as in the case of all other applicants, upon favorable action by the Board of Direction.

Arizona Section—Prize: $10. Recipient: Allen O. R. Drachman, University of Arizona.

Central Illinois Section—Basis: Scholarship; participation in technical activities, including technical writing; engineering experience; qualifications for professional success. Selection: By student award committee appointed annually. Prize: Entrance fee and badge (value of each prize, $12). Recipients: Robert Frank Hastings and Harry Ellsworth Skinner, University of Illinois.

Central Ohio Section—Prize: $10. Recipient: Edward Luther Miller, Ohio State University.

Cincinnati Section—Selection: By Student Chapter prize committee. Prize: Junior membership. Recipient: Paul Stuart Button, University of Cincinnati.

Cleveland Section—Basis: Grades, 75 per cent; student activities, 15 per cent; Chapter activities, 10 per cent. Selection: By committee of professors and chairman of Section's committee on Student Chapters. Prize: Entrance fee, one year's dues, and badge (value of each prize, about $22). Recipients: John William Allen, University of Akron; Ernest W. Taylor, Case School of Applied Science; Ronald Jocelyn Upp, Ohio Northern University.

Colorado Section—Basis: Outstanding paper. Selection: By committee. Prize: Entrance fee (value, $10). Recipient: Robert Edison Rathbun, University of Colorado.

Florida Section—Basis: Outstanding member of class. Selection: By committee. Prize: Entrance fee (value, $10). Recipient: Jack Minor Nelson, University of Florida.

Georgia Section—Basis: Best thesis. Selection: By committee. Prize: One year's dues, Society and Section (value, $11).

Illinois Section—Basis: Outstanding member of class. Selection: By educational committee. Prizes: $10 each. Recipients: James Monroe Baker, Purdue University; Thomas Paul DeWan, University of Illinois; Robert William Martinek, Northwestern University; Paul L. G. Moore, Armour Institute of Technology; Edmund Wisniewski, Lewis Institute.

Indiana Section—Basis: Outstanding member of class. Selection: By committee on student relations. Prize: Entrance fee, balance of year's dues, and badge (value of each prize, $13.67). Recipients: Robert Richard Byington and William Henry Keenan, Purdue University.

Iowa Section—Selection: By deans of engineering colleges (Iowa State and University of Iowa). Prizes: Entrance fee (value of each prize, $10). Recipients: Kenneth Charles Cox, State University of Iowa; Francis Carlton Warrington, Iowa State College.

Ithaca Section—Basis: Student most likely to succeed in profession. Selection: By director of school, Faculty Adviser, and Local Section secretary, with faculty approval. Prize: Entrance fee (value, $10). Recipient: Lawrence Alfred Christensen, Cornell University.

Kansas City Section—Basis: Best paper. Prize: Entrance fee (value, $10). Recipient: Walter Franklin Breuer, Missouri School of Mines and Metallurgy.

Kansas State Section—Basis: Highest scholastic standing. Selection: By head of department. Prizes: Entrance fee (value of each prize, $10). Recipients: Hobart G. Mariner, Kansas State College; Lawrence Neal Bigelow, University of Kansas.

Kentucky Section—Prize: Entrance fee. Recipient: James Edwin Adams, University of Kentucky.

Lehigh Valley Section—Basis: Highest scholastic average, last two years. Selection: By head of department. Prizes: Entrance fee and one year's dues (value of each prize, $20). Recipients: Gilbert Richard Redgrave, Lafayette College; Clarence Benning Welch, Lehigh University.

Louisiana Section—Basis: Outstanding member of class. Prizes: Entrance fee and one year's dues. Recipients: Harold Francis Favret, Tulane University; Octave Leon Fontenot, Louisiana State University.

Los Angeles Section—Basis: Outstanding ability and promise in engineering. Selection: By head of department, confirmed by student adviser from Section. Prizes: Entrance fee and one year's dues. Recipients: Jacob Dekema, University of Southern California; Walter Leon Moore, California Institute of Technology.

Maryland Section—Basis: Thesis. Prizes: $10 each. Recipients: Robert Austin Jackson, University of Maryland; Edward L. Rowny, Johns Hopkins University.

Metropolitan Section—Outstanding member of class (scholarship, 50 per cent; Chapter activities, 20 per cent; other activities, 10 per cent; general characteristics, 20 per cent). Selection: Faculty Adviser and Contact Member nominate two; Section committee on Student Chapters selects one. Prizes (each): Entrance fee and badge; one year's dues in Section; certificate of award. Recipients: Dominic John Bressi, Columbia University; Frank Augustus Busse, Newark College of Engineering; John Francis Curtin, New York University; Giles George Green, Cooper Union; Anthony Frank Romeo, College of the City of New York; Alfred Cornelius Maevis, Polytechnic Institute of Brooklyn; Elmer Joseph Syndennis, Manhattan College; Francis F. Tentschert, Rutgers University.

New Mexico Section—Basis: Scholastic rating, 60 per cent; activities, 30 per cent; aptitude in engineering, 10 per cent. Selection: By engineering faculty. Prizes: Two at $12, one at $10.

North Carolina Section—Basis: Papers. Selection: By committee of three past-presidents. Prizes: Junior membership. Recipients: D. C. Douglas and Daniel Lipschutz, University of North Carolina; Clarence Stephens Gale, North Carolina State College.

Northwestern Section—Prizes: (First) entrance fee, one year's dues, and civil engineering handbook (total value about $28); (second) entrance fee and handbook (total value about $18). Recipients: Earl Theodore Franzen and Loren Lilliard Frickland, University of Minnesota.

Oklahoma Section—Basis: Outstanding student. Prizes: Entrance fee (value, $10). Recipients: Leo Delbert Boswell, Oklahoma Agricultural and Mechanical College; Josiah James Harrison, University of Oklahoma.

Philadelphia Section—Basis: Best papers presented at student convention (composition, 80 per cent; oral presentation, 20 per cent). Selection: Board of three disinterested judges. Prizes: (first) entrance fee and one year's dues, plus $20 cash; (second) entrance fee and one year's dues; (third, donated by Lehigh Valley Section), entrance fee. Recipients: Thomas F. Spencer, Swarthmore College; Robert E. Crispin, Lehigh University; Lewis E. Hoffman, Drexel Institute of Technology.

Pittsburgh Section—Prizes: $10 each. Recipients: William Stanley Beall, Carnegie Institute of Technology; Esther Rosalind Benford, West Virginia University; Frank Bromilow, University of Pittsburgh.

Portland Section—Basis: Best papers presented to Section. Recipients: Henry Sprague Burdin, Jr., William Herbert Edwards, and Henry John Wenderoth, Oregon State College.

Sacramento Section—Basis: Scholarship, extracurricular activities, capacity for success in profession. Selection: By action of Section on recommendation by committee on Juniors. Prize: Entrance fee, badge, and one year's dues in Section (total value $13). Recipient: Daniel Jackson Faustman, University of California.

St. Louis Section—Basis: Papers. Selection: By special committee. Prizes: $10 each.

San Francisco Section—Basis: Student who shows promise of becoming a good engineer. Selection: Faculty committee, subject to approval of Section's board of direction. Prizes (each): Entrance fee and badge. Recipients: Thomas Axel Amneus, University of California; Horace Malcolm Witbeck, Stanford University.

Seattle Section—Basis: Best paper. Selection: By special committee. Prizes: (First) entrance fee; (second) handbook, value $5. Recipient: Glen Robert Butterfield, Jr., University of Washington.

South Carolina Section—Basis: Outstanding member of class. Selection: Majority vote of members of Student Chapters. Prizes (two): One year's dues.

Spokane Section—Basis: Paper. Selection: By committee. Prizes (each): Entrance fee (value, $10). Recipients: Ivan Charles Crawford, Jr., University of Idaho; James Arthur Sewell, Washington State College.

Tennessee Valley Section—Basis: General excellence. Selection: By faculty, and Section's board of directors. Prizes: (first) entrance fee and badge; (second) entrance fee. Recipients: James Benton Clark and George Henry Maxwell, Jr., University of Tennessee.

Utah Section—Basis: Thesis. Prizes (each): Entrance fee and badge (value of each prize, $12). Recipients: Richard Samuel Reinhold, University of Utah; Emery Hyde Willes, Utah State Agricultural College.

Virginia Section—Basis: Honor graduate in civil engineering. Selection: By faculty. Prizes (each): Entrance fee. Recipients: Paul Wilson Cauley, Virginia Polytechnic Institute; Joseph Moreland Cowgill, University of Virginia; David Canfield Hastings, Virginia Military Institute.

Other awards of Junior membership in the Society made at commencement time were: The Milo S. Ketchum Award to Robert Joseph Wolf, of the University of Colorado, made by the Colorado Section; the award made by the Conference of Metropolitan Student Chapters and presented to Francis Lewis Schaffel, of the College of the City of New York; and the Kreusi Prize to Samuel Tolbert Logan, of the University of Tennessee, made by the Tennessee Valley Section.

Society Aids in Clearing Accused Members

UPON the successful culmination of an attempt by the Society to assist members wrongly accused, the principal details may be disclosed. A case in point involves two members, C. R. Olberg and Perry A. Welty. The high lights of this case, which the Society followed from its inception, are set forth in the following resolutions adopted by the Board of Direction in July 1936:

"WHEREAS, Major Charles Real Olberg, Member of the American Society of Civil Engineers, of Washington, D.C., was discharged from the Public Works Administration on January 15, 1935, and was subsequently tried in the Supreme Court of the District of Columbia, together with Mr. Perry A. Welty, also Member of the American Society of Civil Engineers, of Austin, Tex., and five other defendants, on the charge of conspiracy to defraud the Government; and

"WHEREAS, After an exhaustive trial extending from April 20 to June 8, 1936, all seven defendants were acquitted; and

"WHEREAS, By this discharge, and the subsequent indictment and trial, Major Olberg has been subjected to grave injustice and hardship, having been precluded from Government employment by the terms of his discharge, subjected to great mental strain and expense, and deprived of other opportunities for employment; and

"WHEREAS, Major Olberg has an unblemished record of service in various departments of the Government covering many years, including 14 months with the A.E.F. during the World War; and

"WHEREAS, The acquittal, after due trial, fully confirms the confidence in Major Olberg's efficiency, loyalty, and integrity entertained by his fellow engineers and other associates; and

"WHEREAS, Official action by the Federal Government is essential to correct the injustice done Major Olberg and to make available to him the opportunity for further government employment; and

"WHEREAS, Such official action has not been taken;

"*Therefore, Be It Resolved*, That the Board of Direction of the American Society of Civil Engineers, by unanimous action, respectfully requests the President of the United States to use his executive authority to secure the restoration of Major Olberg, without prejudice, to Government Service."

"WHEREAS, Perry Allen Welty, Member of the American Society of Civil Engineers, was indicted and subsequently tried in the Supreme Court of the District of Columbia, together with Major Charles R. Olberg, also Member of the American Society of Civil Engineers, and five other defendants on the charge of conspiracy to defraud the Federal Government; and

"WHEREAS, After an exhaustive trial extending from April 20 to June 8, 1936, all seven defendants were acquitted; and

"WHEREAS, By this indictment and trial, Mr. Welty has been subjected to grave injustice and hardship, to prejudice from securing other employment by reason of this indictment, and subjected to great mental strain and expense; and

"WHEREAS, Mr. Welty has an excellent record as a professional engineer in various capacities and the high regard of the engineering profession; and

"WHEREAS, This acquittal after due trial from which there is no appeal, fully confirms the confidence in Mr. Welty's efficiency, loyalty, and integrity entertained by his fellow engineers and other associates; and

"WHEREAS, Official action by the Federal Government is essential to correct the injustice done to Mr. Welty and to make available to him the opportunity for further employment; and

"WHEREAS, Such official action has not been taken;

"*Therefore, Be It Resolved*, That the Board of Direction of the American Society of Civil Engineers, by unanimous action, respectfully requests the President of the United States to issue and file with the record such documents as may be necessary to insure that this indictment and trial will not operate to the prejudice of Mr. Welty in any further employment that he may seek."

There remained the necessity for clearing the records of both men before the U. S. Civil Service Commission in order that either or both might be reemployed without prejudice in the federal service. The Society participated actively in efforts to that end and now is pleased to report to the membership that the records of both men have been so cleared and that Major Olberg is again employed in the federal service.

Otis E. Hovey Made Director of Engineering Foundation

ON OCTOBER 14, Otis E. Hovey, Hon. M. Am. Soc. C.E., was made director of the Engineering Foundation, succeeding the late Alfred D. Flinn, M. Am. Soc. C.E. Mr. Hovey, who has been engaged as a consulting engineer in New York City, has long been active in the affairs of the Society. He was elected Associate Member in 1894, Member in 1900, and Honorary Member in 1937, and has served as treasurer of the Society since 1921.

"Many Happy Returns of the Day"

ON NOVEMBER 5, the American Society of Civil Engineers will round out its eighty-fifth year. It was on that date in 1852 that twelve men assembled in the Croton Aqueduct Department offices in the city of New York, to draw up the original Constitution and By-Laws and elect the first officers. From that small beginning the Society has grown to its present membership of over 15,000, and its geographical scope has extended to all quarters of the globe.

May its past successes be a stimulus to still greater service to the profession in years to come.

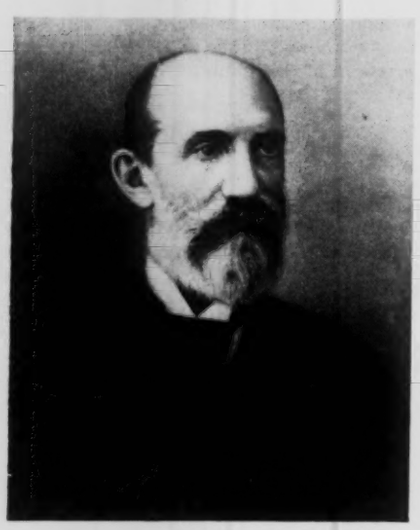
Early Presidents of the Society

XX. WILLIAM POWELL SHINN, 1834–1892

President of the Society, 1890

This is the twentieth in the series of biographical sketches of famous pioneers in American engineering. The subjects of the next three articles will be Octave Chanute, Mendes Cohen, and William Metcalf. Any assistance that readers can give in supplying interesting stories of these men or illustrations connected with their activities will be heartily welcomed.

TWO BRICKLAYERS were repairing a furnace in the steel mill one day when William Powell Shinn strolled by on a tour of inspection. One of them paused, trowel in air, and nudged his companion. "There goes that . . . bookkeeper," he mumbled. "If I use a dozen brick more than I did last month, he'll know it and come round to ask why."



WILLIAM POWELL SHINN
Twentieth President of the Society

If Shinn heard the comment, he must have smiled inwardly and considered himself complimented. For as managing partner of the Edgar Thomson Steel Company he prided himself on a system of cost accounting that had gone far towards putting his firm in the forefront of its competitors in the new industry of the 1870's.

Shinn's contribution to the founding and early successes of the Carnegie Steel Company was doubtless the outstanding work of his life. But its details, perhaps, should wait their chronological turn.

William Powell Shinn was born in 1834 in Burlington, N.J.; his father was a carpenter and builder by trade. After receiving such elementary schooling as the town provided, he went to Pittsburgh at the age of 16 and went to work as a rodman on the Ohio and Pennsylvania Railroad.

Promotion followed rapidly—in part by virtue of his own qualifications; in part, doubtless, because of the tremendous demand for engineering talent throughout the country. A month before his nineteenth birthday he became principal assistant engineer on the Fort Wayne and Chicago Railroad.

By the time he attained his majority he had already practically abandoned the active practice of railway location and construction, and had begun to occupy himself with the details of traffic and general management. His first work along this line was as auditor of the freight accounts of the Ohio and Pennsylvania. In 1856 he took charge of the freight accounts of the Pittsburgh, Fort Wayne and Chicago Railway, and in the following 15 years he served that company variously as general bookkeeper, general passenger agent, division superintendent, and general freight agent.

In 1871 the Pennsylvania Company was organized for the control of western railroads tributary to the Pennsylvania Railroad, whose western terminus was then at Pittsburgh. Shinn became the general agent of the new organization, and was intrusted with the important and confidential work involved in studying the financial affairs and physical condition of the lines that, by purchase or lease, were being incorporated into the system.

He was also commissioned, in 1870, by the Pennsylvania Railroad Company, to investigate the condition of the United Railroads of New Jersey (including its canal properties and ferry lines). His exhaustive report determined the lease of these important properties to the Pennsylvania, and led to the adoption of a number of important improvements suggested by him. Between 1871 and 1873 he built the Ashtabula, Youngstown and Pittsburgh Railroad (since 1910 a part of the Pennsylvania system), and in the following two years served as its president.

The story of Shinn's connection with the steel industry is interestingly told in *The History of the Carnegie Steel Company* by James Howard Bridge (1903). The title page reads: "To recall their forgotten services, this history of a great business is dedicated to the memory of the men who founded it, saved it from early disaster, and won its first successes." Shinn's name is one of the eight that follow.

In 1871, according to Bridge's account, William Coleman and his son-in-law, Thomas Carnegie (younger brother of Andrew), secured a site for a steel works to use the then new Bessemer process, about 12 miles above Pittsburgh. The elder Carnegie was not interested in financing it; he was none too sure of the future of the Bessemer process, and did not think pioneering profitable. So David McCandless, a merchant and banker of Pittsburgh, was solicited, and he agreed to go into the venture on condition that his friend Shinn be taken in and made treasurer. The others approved, and Shinn subscribed one-fourteenth of the $700,000 capital. About this time, Andrew Carnegie made a trip to Europe, and came back thoroughly convinced of the value of the Bessemer process. So, after all, he came in on the ground floor.

"Thus was started," says Bridge, "the great enterprise which afterwards became famous as the Edgar Thomson Steel Works." One factor "which contributed in no small degree" to its success "was the voucher system of accounting which Mr. Shinn introduced. This had long been used by railroads, . . . but was not in general use in manufacturing concerns. No order for rails was ever accepted until there had first been ascertained the actual cost of every element entering into their manufacture, and options obtained on the pig-iron of which they were to be made." Shinn's monthly cost sheets "were marvels of ingenuity and careful accounting."

The functions of the various partners were humorously described thus by an associate: "Shinn bossed the show; McCandless lent it dignity and standing; Phipps took in the pennies at the gate. . .; Tom Carnegie kept everybody in good humor; . . . and Andy looked after the advertising and drove the bandwagon." According to Bridge, this blunt comparison, with due allowance for humorous exaggeration, fairly represented the facts.

The first rails were rolled at the Edgar Thomson works in 1873; five years later the firm showed annual earnings of $401,000—over 31 per cent on its capital of $1,250,000—and in 1879 the annual profit was $1,625,000. The important services of Shinn, the "bookkeeper," during this period of tremendous growth, can scarcely be overestimated. His name, Carnegie once said in a letter, was used by his associates "as a prayer of thanksgiving every night before going to bed." On one occasion, for example, he worked out a new metal mixture for ingot molds that effected a saving of $40,000 a year on the plant's production—"a sum almost sufficient in itself to determine the financial success or nonsuccess of the work under ordinary conditions of trade."

In these early years, disputes arose between Carnegie and the other partners, and one by one they left the concern. In 1877, Carnegie wrote to Shinn that "you, out of the entire lot, would be wanted as a future partner." But, surprisingly enough, it was only two years later that a bitter quarrel led to Shinn's resignation as manager, and culminated in a long and bitter fight in the courts. The main issue of this battle Shinn eventually won, but his connection with the Carnegie interests was never renewed. He later, however, reorganized the Vulcan Steel Company, of St. Louis, and rebuilt their works.

In 1879 two men appeared almost simultaneously in New York with ideas that were destined to revolutionize urban life. One was Edison, with his electric light and power projects, and the other was Wallace C. Andrews, with his plan for central steam heating. Andrews, a financier, engaged Charles Edward Emery, M. Am. Soc. C.E., to investigate the heating proposition from every angle, particularly the pioneer work of Birdsill Holly at Lockport, N.Y.

The initial study showed promise, and within a year the Steam Heating and Power Company embarked on its ambitious project, with Holly's work in a small village as its only precedent. In

1881 the firm merged with the New York Steam Company, taking the name of the latter, and Shinn became its vice-president. He remained in this capacity until 1887.

The business started with 62 customers in 1882. The trials and tribulations of the installation are recounted in *50 Years of New York Steam Service*, a fascinating history published by the company in 1932. Credit for the technical details is Emery's rather than Shinn's, but Shinn had his own problems along financial lines to surmount.

For a while the company operated on the proverbial shoestring. In the early years Shinn and the other managers used to eat regularly in a certain restaurant—not because they particularly liked the food, but because the owner was a subscriber to the steam service and also a stockholder of the company, and they hoped that if he heard enough of their financial straits he would be induced to pay his bill in advance. (The scheme worked.)

By the time Shinn resigned the vice-presidency in 1887, the New York Steam Company was well on its feet and growing rapidly. It is of interest to note here that their first boiler plant, in downtown New York, was credited by *The Times* in 1882 as having given half the population a stiff neck. Its 225-ft chimney dominated the skyline for many years.

Shinn returned to railroad work again in 1887, as vice-president and general manager of the New York and New England Railway Company (now part of the New York, New Haven and Hartford). At the same time, however, he continued his interest in various Pittsburgh industries, notably the Mansfield Coal and Coke Company, of which he was one of the organizers and for several years president. In 1891, also, he organized the United States Glass Company, a consolidation of 16 manufactories with a combined capital of $4,000,000.

The new constitution of the Society, adopted in 1891, was to a considerable extent the work of Shinn. His ability as a parliamentarian and his legal knowledge of corporate affairs were of great assistance in bringing it into shape, and it was accepted by the membership with but a few slight modifications. This constitution is of note in that it broadened the geographical scope of the Board of Direction by increasing the number of Vice-Presidents from 2 to 4, and the number of Directors from 5 to 18, so selected that there were always two from each of the six "non-resident" districts. It also stiffened the requirements for the grade of Member, and established the grade of Associate Member.

Shinn's other contributions to the Society must be treated briefly here, though they were of outstanding importance. His paper on "Railroad Accounts and Returns" published in TRANSACTIONS, 1876, aimed at the establishment of a uniform system of railroad accounting, the plans for which were to be formulated by a committee of the Society acting in conjunction with the state commissioners. Although the recommendations failed, the ensuing discussion resulted in a partial adoption of his suggestions by the commissioners. Shinn also was chairman of a Society committee that made some of the earliest studies on train resistance with the use of the dynagraph. The studies led to some surprising conclusions that attracted very general attention in the railroad world in the 1870's.

Shinn's personal habits were quite the opposite of what one might expect. He was quiet and reserved, and "his mode of life was exceedingly frugal—almost severe in its simplicity, so much so as to suggest the question how, with his plain and meager sustenance, he could maintain the remarkable mental activity and intellectual energy with which he taxed himself."

The writer of his memoir (Max Joseph Becker) continues: "In his domestic relations he always appeared quietly happy and contented. Left without children, all his affections were bestowed upon his feeble and delicate wife, who. . . received his undivided attention and unremitting care." It is of interest to note that the attendance of ladies at the Annual Conventions was a custom inaugurated by Mr. and Mrs. Shinn.

This sketch may well conclude with an excerpt from Shinn's address at the 1890 Annual Convention, on a professional topic that is as lively and timely today as then. He is speaking of "expert testimony":

"Nothing can be more unseemly than to see two eminent members of any profession each striving to earn his fee by stating such facts only as make for the side by which he is retained. The differences of opinion which naturally must exist are thereby stimulated and intensified until all respect for scientific opinions is lost by the laymen, who have no knowledge of the subject.

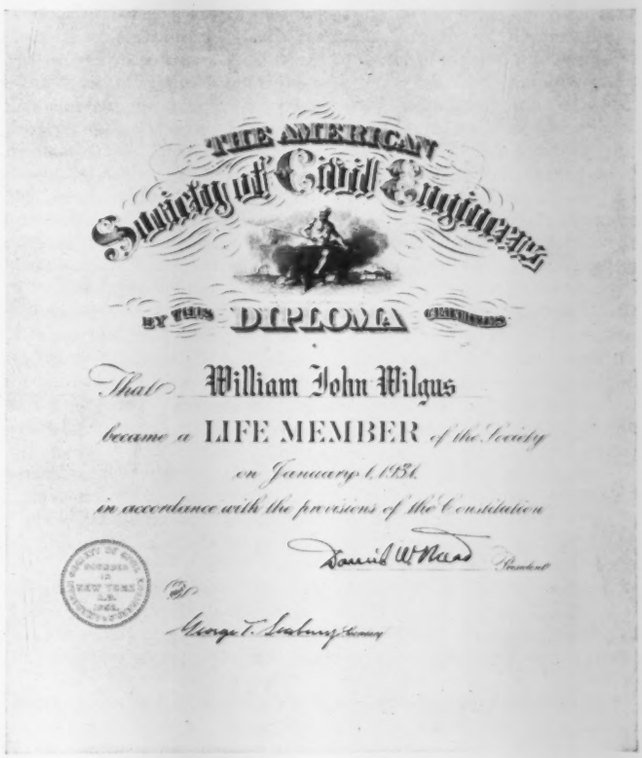
"It has long been my opinion that the expert witness should be called by the court, and that he should be allowed to state facts and opinions free from the trammels of *suppressio veri* so often employed by the attorneys on either side. It might result in some of my professional brethren receiving less fees, but it would be to the benefit of the profession and the cause of justice. . . .

"In questions of any kind upon which an opinion is to be given or a statement is to be made, let it be based upon the best possible ascertainment of the facts, for the statement of the civil engineer should 'import absolute verity.' "

First Life-Membership Certificates Presented

MEETINGS of three Local Sections during the week of October 10, 1937, featured the presentation of the newly devised life-membership certificates to 14 members of the Society. At Omaha, on October 12, the Nebraska Section thus honored Theodore A. Leisen. The following day the Portland (Ore.) Section presented the certificates to William Wesley Amburn, Russell Chase, Joseph Pettus Newell, Melville Emerson Reed, and Ernest Burslem Thomson. And the Texas Section, at its annual meeting at Tyler on October 15–16, presented them to Frank Lynton Chase, John Blackstock Hawley, Francis Dey Hughes, Otto Heinrich Lang, Edwin Jay Nichols, Thomas Ulvan Taylor, Robert Andrew Thompson, and Frank Herbert Todd.

The idea of giving individual recognition to Life Members in the form of a certificate originated with the Texas Section in 1936, and was approved by the Board of Direction in December of that year. Certificates are now being prepared for the more than 800 Life Members, and will be distributed as rapidly as possible. Texas also made the first plans for a presentation ceremony, and the idea has met with favor in a large number of Local Sections, which have scheduled similar events for the coming months. In all cases where Local Sections are not planning to sponsor the presentation, certificates will be mailed to Life Members from Society Headquarters.


THE AMERICAN
Society of Civil Engineers
BY THIS DIPLOMA
That William John Wilgus
became a LIFE MEMBER of the Society
on January 1, 1934
in accordance with the provisions of the Constitution
President
By
Treasurer

A LIFE-MEMBERSHIP CERTIFICATE SOON TO BE PRESENTED
It Can Be Trimmed to Fit in a Corner of the Regular Certificate of Membership

Preparing Memoirs of Deceased Members

Some Suggestions to Enhance the Value of These Permanent Records

ONE OF the important functions of the Society is the soliciting and printing of memoirs of deceased members. As a gage of their aggregate bulk, consider the fact that they account yearly for about 15 per cent of volume in the permanent record—TRANSACTIONS. Furthermore, some biographies, even of widely known engineers, are unobtainable despite the repeated efforts of the editors to secure volunteer authors. Much study and labor are expended, usually by friends or associates, and much work by the Headquarters staff goes into the editing, proof-reading, and distributing of this material. No phase of Society effort prompts more letters of gratitude and more genuine appreciation than the kindly act of furnishing a few copies to members of the family, friends, and relatives. On its part, the Society is deeply appreciative of the efforts of those who compile such permanent records.

In order to simplify the work of preparing memoirs, for those to whom it may appear something of a bugbear, a few observations based on considerable experience at Headquarters may be helpful. The Committee on Publications invites the author (or authors) selected to prepare a memoir to choose his own literary style and content, and to use his own fair judgment as to a reasonable length. The desire is to avoid publishing either trite and stereotyped accounts or verbose records, which tend to belittle rather than extol the accomplishments of the deceased. Only three invariable rules have been established by the Society in connection with memoirs:

1. The record must be headed by a title, with the man's name and grade of membership in the Society, followed in the next line by the date of his death.

2. The record must end with a statement of the man's date of election to the Society.

3. No photograph will be published with a memoir.

The editorial department has standing instructions to suggest any other improvement, and to accord the author the privilege of vetoing such suggestions or making still better ones on the edited manuscript. A partial list of such suggestions are:

4. A Society memoir differs from a newspaper obituary, magazine item, or memorial pamphlet in that it is intended to record for all time the accomplishments of the individual engineer, and the mass contribution of civil engineers in general to the life of the age in which they live. Copies of individual memoirs are transmitted to survivors as an official mark of respect by the Society, anticipating that, in many cases, they will be preserved as part of the prized records of the family. Therefore, subjects of transient interest might well be avoided.

5. Some tribute to the character, or some illustration of the personality, of the deceased, is desirable as well as comment on his net contribution to the professional and community life of his day and generation. He thus appears as the virile center and subject of the account rather than as a distant and inanimate object.

6. Padding by use of extensive quoted matter is objectionable because (*a*) it generally makes tiresome reading; (*b*) the connection between the quotation and the subject of the memoir is not always clear to the reader; and (*c*) a footnote page reference to the original source would serve the purpose as well. It is suggested that authors paraphrase quoted matter, delete it entirely when possible or, in any case, quote sparingly.

7. Apply to the deceased the title, if any, to which he was entitled at the period of which the author is writing. Avoid referring to "General Blank" if, at the time, he was still "Lieutenant Blank," and avoid using such improbable titles as "Professor" when speaking of the deceased in his early years.

8. Introduction of extensive "Memoir" material pertaining to associates, members of the family, or descendents of the deceased may constitute a digression. On the other hand, geneological data pertaining to his direct ancestors can be made very interesting and pertinent.

9. Laudatory descriptions of proprietary articles, active commercial concerns, engineering textbooks, etc., except in so far as they are necessary to emphasize the character and attainments of the deceased, are usually considered beyond the scope of a professional society. They tend to weaken the memoir and detract from its dignity.

10. Restrictions as to the use of the first and second person are not applied to memoirs, but authors will wish to minimize such use in order to avoid focusing primary attention on themselves rather than on the deceased.

11. If a thorough tabulation of the engineering assignments of the deceased has been printed previously in some widely distributed, permanent directory of notable men (such as the various types of Who's Who), an author may choose to minimize the repetition of such material in the memoir, citing only full footnote page references to the prior publication, and emphasizing the more salient phases of the man's career in an attractive narrative form. The extent to which detailed listing of engineering assignments should be recorded is left to the discretion of the author.

12. If a memoir has been published previously by another organization, or if such publication is pending as a fact or a possibility, the Society would prefer to have its memoir prepared by a separate author or committee.

13. Vague expressions such as "recently" and "a few years ago," which may be perfectly logical in a news obituary, tend to obscure the meaning of a professional record printed in the yearly TRANSACTIONS.

14. Original manuscripts should preferably be double spaced, with generous margins, and should not be carbon copies. This is a courteous concession on the part of the author, to expedite the work of the editor and the printer.

It is not intended that the foregoing suggestions should be restrictive but rather that they should lighten the work of compiling a memoir. Furthermore, it may be helpful to keep in mind the fact that the career and character attributes of the deceased are the subjects of prime interest. It is hoped that authors will feel the widest latitude in developing their accounts into fitting and dignified tributes for permanent record.

New York Local Sections Make Recommendations for Civil Service Grades

IN A LETTER addressed to the Temporary Salary Standardization Board of the State of New York, dated September 25, 1937, a joint committee representing the Buffalo, Ithaca, Metropolitan, and Syracuse Sections of the Society recommended the adoption of eight specific grades for engineers in the state service, on a salary basis equal to that provided for other professions having equal qualifications. This action is an excellent example of an initial step by Local Sections designed to assist engineers to secure in their respective communities the adoption of recommended salary scales by employing agencies.

The brief submitted by the New York Local Sections is in part as follows:

"The ever-increasing complexity of governmental problems demands that the engineering personnel of the State Civil Service be composed of the best engineering talent, and the maintenance of the present high standard of quality will depend in great measure on the allocations you will make.

"The Education Law of the State of New York has defined the term 'Professional Engineer' and has established the qualifications requisite to obtain such designation by the Licensing Board. The Joint Committee therefore recommends:

> That only such engineering titles be allocated to Professional Service (Section 7) as require qualifications equal to those established by the Education Law, and that the following schedule of allocations be made:

TITLE	GRADE
Junior Engineer . . . 2	Asst. Chief Engineer Assistant Commissioner Assistant Director Engineer-Secretary Executive Engineer — 6 & 7
Assistant Engineer . . 3	
Senior Engineer . . . 4	
Associate Engineer . . 5	
Principal Engineer Asst. District Engineer District Engineer — 6 & 7	Commissioner Chief Engineer Director — . . . 8

"The recommended schedule has been based on the principle of allocating the highest civil service title, reporting directly to a de-

partmental head, to Grade 8. The executive and administrative titles below that of commissioner, chief engineer, or director have been allocated to Grade 6 and 7. Engineering titles below the executive or administrative class have been allocated in logical relation. No title demanding qualifications requisite for the status of Professional Engineer should be allocated below Grade 2.

"The Joint Committee has prepared its recommendations on the basis of the declared policy of the State as defined in Section 1 of Chapter 859 '. . . to provide equal pay for equal work,' and believes that the purpose of the Chapter '. . . to ensure to the people and the taxpayers of the State of New York the highest return in services for the necessary costs of government,' will be more certainly accomplished by providing compensation for engineers equal to that provided for other professions demanding equal qualifications of educational training and experience and exercising like responsibility of office.

"The above recommendations are in accord with the conclusions of an extensive study of salaries now in process by a committee of the American Society of Civil Engineers. The Joint Committee will appreciate the opportunity of supplementing this brief by further correspondence or by personal appearance should your Honorable Board desire more detailed data in support of the above recommendations."

The brief was signed by William T. Huber for the Buffalo Section, John E. Perry for the Ithaca Section, D. B. Steinman for the Metropolitan Section, and Earl F. O'Brien for the Syracuse Section, and was acknowledged with thanks by Frank L. Tolman, secretary to the State Temporary Salary Standardization Board.

Engineering Curricula Accredited by Engineers' Council

FOR the first time in the history of engineering education in the United States, engineering curricula throughout the country have been appraised by a representative body of engineers, and a single accredited list has been published of courses of study deemed worthy of approval. The accrediting process has been carried out during the past two years by the Engineers' Council for Professional Development (E.C.P.D.), a joint organization created by seven national engineering societies for the purpose of enhancing the status of the engineering profession. The participating groups are the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, and the National Council of State Boards of Engineering Examiners.

Working through four committees, E.C.P.D. inaugurated a program dealing with the selection, guidance, training, and recognition of members of the engineering profession. The objective of the Committee on Engineering Schools was "to formulate criteria for colleges of engineering, which will insure to their graduates a sound educational background for practicing the engineering profession," and to give recognition to those institutions prepared to teach engineering according to acceptable standards. Accrediting was based on both qualitative and quantitative criteria, and the procedure involved the use of an extensive questionnaire and a personal visit to each institution by a committee of engineers. Participation of the educational institutions was voluntary, and inspection was made only at their invitation.

Announcement of the accredited list, including those curricula examined last year in the New England and Middle-Atlantic states, was made at the fifth annual meeting of E.C.P.D. on October 1, 1937. On that date 107 engineering schools had been visited and 445 curricula accredited in 16 branches of engineering. Committees of inspection throughout the country numbered 102 engineers.

The accredited list does not include certain specialized curricula submitted for consideration, which, although apparently outstanding in restricted fields, are not closely related to engineering as interpreted by E.C.P.D. Nor does it include five institutions which have applied for accrediting with the request that the visits of inspection be made in 1937–1938. Finally, provision is made by E.C.P.D. for annual review of the accredited list through its Committee on Engineering Schools, of which Dr. Karl T. Compton, President, Massachusetts Institute of Technology, is chairman.

Requests for further information regarding E.C.P.D. and the accrediting program may be addressed to A. B. Parsons, Secretary, E.C.P.D., 29 West 39th Street, New York, N.Y.

The institutions whose civil engineering curricula have been accredited are as follows:

University of Alabama
University of Arizona
University of Arkansas
Armour Institute of Technology
Brown University
Bucknell University
University of California
California Institute of Technology
Carnegie Institute of Technology (*a*)
Case School of Applied Science
University of Cincinnati
The Citadel
Clarkson College of Technology
Clemson Agricultural College
College of the City of New York (*a*)
University of Colorado
Columbia University (*b*)
Cooper Union Institute of Technology (*c*)
Cornell University
Dartmouth College
University of Delaware
University of Detroit
Drexel Institute
Duke University
University of Florida
Georgia School of Technology (*d*)
Harvard University (*e*)
Howard University
University of Idaho
University of Illinois
Iowa State College
State University of Iowa
Johns Hopkins University
University of Kansas
Kansas State College
University of Kentucky
Lafayette College
Lehigh University
Lousiana State University
University of Louisville
University of Maine
Marquette University
University of Maryland
Massachusetts Institute of Technology (Civil Engineering)
Massachusetts Institute of Technology (Building Engineering and Construction)
University of Michigan (Civil Engineering)
University of Michigan (Engineering Mechanics)
University of Michigan (Transportation Engineering)
Michigan College of Mining and Technology
Michigan State College
University of Minnesota
University of Missouri
Missouri School of Mines and Metallurgy
Montana State College
University of Nebraska
University of New Hampshire
University of New Mexico
New York University (*a*)
Newark College of Engineering
North Carolina State College
University of North Dakota
Norwich University
Ohio State University
University of Oklahoma
Oklahoma Agricultural and Mechanical College
Oregon State College (Excluding Business Option)
University of Pennsylvania
Pennsylvania State College
University of Pittsburgh
Polytechnic Institute of Brooklyn (*a*)
Princeton University
Purdue University
Rensselaer Polytechnic Institute
Rhode Island State College
Rice Institute
Rose Polytechnic Institute
Rutgers University
University of Santa Clara
South Dakota State College
South Dakota State School of Mines
Stanford University
Swarthmore College
Syracuse University
University of Tennessee
University of Texas
Agricultural and Mechanical College of Texas
Texas Technological College
Tufts College
Tulane University of Louisiana
Union College
University of Utah
University of Vermont
University of Virginia
Virginia Military Institute
Virginia Polytechnic Institute
Washington University
University of Washington
State College of Washington
West Virginia University
University of Wisconsin
Worcester Polytechnic Institute
Yale University

EXPLANATORY NOTES

(*a*) Accrediting applies to both the day and evening curricula.
(*b*) Accrediting applies to the four-year and five-year curricula leading to the bachelor of science degree.
(*c*) Accrediting applies to day curriculum only. Action on evening curriculum deferred pending granting of degrees.
(*d*) Accrediting applies to both regular and cooperative curricula.
(*e*) Accrediting applies only to curriculum as submitted to E.C.P.D. and upon completion of which a certificate is issued by Harvard University certifying that the student has pursued such a curriculum.

Preview of Proceedings

By HAROLD T. LARSEN, *Editor*

Municipal and sanitary engineers, city planning specialists, hydraulic engineers, highway engineers, specialists in economics and finance; and, secondarily, construction engineers, structural engineers, irrigation engineers, and hydroelectric power specialists—all these should find one or more sections of the November issue of "Proceedings" valuable. This checks the roster of all the Divisions of the Society except, perhaps, three, and is a fair demonstration of the kind of "Proceedings" the Committee on Publications is trying to create.

MULTIPLE STAGE SEWAGE SLUDGE DIGESTION

A great mass of practical operating data has been assembled to form the basis of a new paper on sludge digestion, a subject upon which little authentic information has been published in the past. This paper, which is entitled "Multiple Stage Sewage Sludge Digestion," is by A. M. Rawn, M. Am. Soc. C.E., A. Perry Banta, Assoc. M. Am. Soc. C.E., and Richard Pomeroy, Esq. It is one of these that made the meeting of the Sanitary Engineering Division in New York City in January 1936, a gathering worthy of its large attendance. A severely condensed abstract of the paper was published in the March issue of CIVIL ENGINEERING. In its present form the authors offer a technical paper, complete within its well-defined scope, for discussion and comment.

LABORATORY INVESTIGATION OF FLUME TRACTION AND TRANSPORTATION

Few problems in hydraulics are as complex as those that concern the transportation of debris, and few have in recent years engaged the attention of so many investigators. Knowledge of the subject is in a state of flux, and wide differences of opinion exist. At this time, therefore, a paper that surveys the entire field should be especially welcome. Such a paper is "Laboratory Investigation of Flume Traction and Transportation," by Y. L. Chang.

The subject is presented under three main headings. Part I is concerned principally with the tractive force required to cause initial movement of debris; the laboratory investigation by the writer is described in detail, an equation for critical tractive force is presented, and the results obtained by other investigators are tabulated and shown to conform generally to the same equation. Part II deals with the laws of transportation by traction, and Part III, with the laws of transportation by suspension. In each case Mr. Chang's experiments are reviewed briefly, while the major part of the presentation consists of theoretical analyses and discussions of the work of other experimenters.

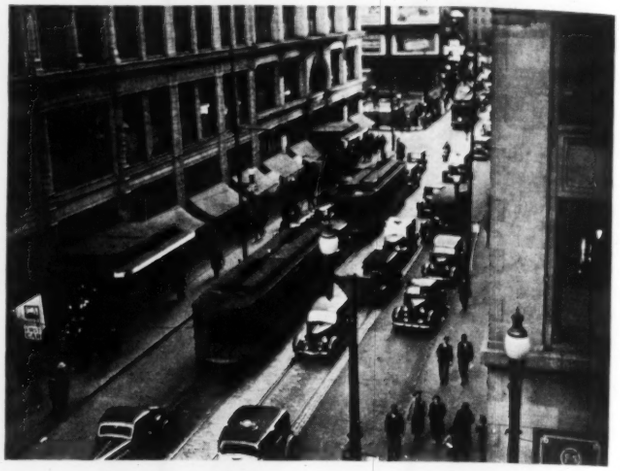
INCREASING THE TRAFFIC CAPACITY OF THOROUGHFARES: A SYMPOSIUM

Traffic congestion in relation to highway improvements—the causes of congestion and suggested remedies; the cost of action in terms of dollars; and the cost of inaction in terms of accidents—this is the subject of a comprehensive symposium entitled "Increasing the Traffic Capacity of Thoroughfares." Three of the papers were presented at the meeting of the City Planning Division, held at the time of the Pittsburgh Meeting of the Society in October 1936, and one at the meeting of the Highway Division, in connection with the Annual Meeting of the Society in New York City last January.

The three papers, based on experience in and around Pittsburgh, in Allegheny County, Pennsylvania, were reviewed very briefly in CIVIL ENGINEERING for January 1937, and these reviews should serve as an ample "preview." Similarly, a few comments on the fourth paper, based on experience in the state of New Jersey, were published in the March 1937 issue of CIVIL ENGINEERING. The papers now being presented for discussion are much more complete.

The first paper of the symposium, "Causes of Failure in Handling Traffic," by L. W. McIntyre, M. Am. Soc. C.E., states the problem and presents detailed statistics upon which the conclusions of subsequent writers rest. The second paper, for example, entitled "Remedies to Relieve Traffic Congestion" is supported directly by the tabular data in the paper by Mr. McIntyre. This second paper is by Donald M. McNeil, Jun. Am. Soc. C.E.

The third paper, entitled "Improvement to Reduce Traffic Accidents," by Arnold H. Vey, Esq., is based upon traffic experiences in the state of New Jersey and relates to the broad subject of the symposium in that it outlines the influence of traffic hazards in restricting the capacity of thoroughfares, and offers valuable advice in designing highways to reduce accidents. It might be said that the keynote of Mr. Vey's thesis is to be found in a significant statement to the effect that, if it were possible to reconstruct the



VIEW OF ONE-WAY STREET, SHOWING SLOW AND FAST-MOVING VEHICLES USING SEPARATE LANES EXCEPT FOR RIGHT TURNS

35,000 miles of improved and unimproved highways in the state of New Jersey, highway accidents could be reduced to a number 75 per cent less than the present accident toll. Conceding that this action is impracticable from an economic standpoint, he urges that in new highway improvement, the design and construction be such that it will be difficult or less possible for drivers to perform improper practices causing accidents. Finally, the last paper entitled "Economics of Alignment, Grade, and Width" by E. L. Schmidt, Esq., sums up the entire case by discussing how much the necessary improvement to increase the capacity of thoroughfares, will cost. One of the solutions of the traffic congestion problem discussed in this symposium, is demonstrated in the accompanying photograph. In this case, a crowded street has been made "one-way" with slow-moving and fast-moving traffic using separate lanes, right turns being permissible.

ABRIDGED TRANSLATIONS OF HYDRAULIC PAPERS

Engineers in all types of hydraulic work will be interested in the collection of abridged translations of hydraulic papers presented in this isssue of PROCEEDINGS. German, French, Italian, and Spanish hydraulicians are represented, and the subjects range from laboratory studies of the roughness problem to a discussion of practical means for computing flow conditions in channels with steep slopes.

This collection of translations is the outgrowth of an idea first presented by Donald P. Barnes, Assoc. M. Am. Soc. C.E., in 1933. Mr. Barnes envisaged an informal organization of recipients of the John R. Freeman Traveling Scholarships, for the purpose of stimulating the translation of hydraulic papers that would not otherwise be available to American engineers. In April 1935 he transmitted a detailed proposal for such translations to the Committee on Publications, pointing out at that time that although the work was initiated "as an expression of appreciation for John R. Freeman's efforts in behalf of the profession," the identity of the translators was immaterial and the participation of all interested persons was welcomed. The Committee gave its general approval to the proposal, and by the spring of 1937 a representative group of papers had been assembled. Following endorsement by the Special Committee on Hydraulic Research, and review by other experts, nine papers were accepted for publication.

These translations are not subject to discussion, and will not appear in TRANSACTIONS. Reprints of individual papers will not be available, but a limited number of reprints of the entire collection will be stocked for sale at 80 cents each (40 cents to members).

For the information of the Committee on Publications, readers are cordially invited to communicate their reactions to this collection to the Manager of Publications.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies Located in 40 States

GOVERNMENT REORGANIZATION

SOME OBSERVERS feel that it is for the best that no action was taken on government reorganization in the confusion which obtained during the hurried days of the last session of Congress. The delay gives citizens time to investigate the proposed reorganization program and to express their opinions to members of Congress. Council, therefore, invites the attention of member societies to the following facts regarding the present status of government reorganization ideas and legislation.

Congress left S. 2970 and H. R. 7730, H. R. 8276 and H. R. 8277 on its calendars as proposals for the reorganization of the federal government of the United States. S. 2970, which was introduced to reduce resistance to the original proposition for reorganization, was reported back to the Senate without amendment and with the recommendation that it should pass.

H. R. 7730, providing the President with six administrative assistants, was reported to and passed by the House without hearings but failed to receive consideration by the Senate. H. R. 8276, creating a general auditing office, and H. R. 8277, revamping the Civil Service System, were reported without hearings and left on the calendar of the House at the close of the session.

Engineers and engineering societies wishing to exercise their rights to advise members of Congress on this vitally important issue should contact members of Congress while they are at home. Council will be glad to have copies of all such communications for the information and guidance of officers, staff, and committees who may be called upon for expressions of engineering opinion by the investigating committees and members of Congress.

U. S. HOUSING AUTHORITY

The U. S. Housing Authority became a reality with the signing of the Wagner-Steagall Public Housing Bill by President Roosevelt on September 3, 1937. In final form, the Act gives the Secretary of the Interior general supervision of the U. S. Housing Authority but vests the real power of the Authority in "an administrator to be appointed by the President by and with the advice and consent of the Senate."

A half billion dollars is to be entrusted to the administrator with very few restrictions. In addition, the President may, at any time within his discretion, transfer to the Authority any right, interest, or title held by any department or agency of the federal government in any housing or slum-clearance project, including unexpended balances of funds heretofore allocated for such purposes, and employees engaged in housing or slum-clearance. The Authority may continue any or all activities undertaken in connection with projects thus transferred to it from other agencies. The Authority may also accept and utilize voluntary and uncompensated services of employees of federal, state, and local governments found desirable in the performance of its many duties.

In a spirit of helpfulness, Council made the following statement to President Roosevelt, who has expressed his appreciation for the views of engineering organizations:

"Engineers appreciate the difficulty involved in choosing an Administrator . . . . Several branches of the engineering profession in the United States are thoroughly familiar with the housing situation. Many engineers are engaged in public and private housing enterprise, and some are well-known authorities on urban planning which involves the elimination of unsafe and unsanitary housing conditions. The American Engineering Council will welcome all opportunities to be of service to you and to the Administrator othe U. S. Housing Authority."

BUILDING MATERIALS RESEARCH

Building materials research is being emphasized with particular reference to low-cost housing by the U. S. Bureau of Standards under authority and a grant of $198,000 by the last Congress. The general objective of the work is to furnish government agencies, the building industry, and the public with technical information from every available source on the engineering properties of building materials as incorporated in the structural elements and equipment of a house, with particular reference to low-cost housing. It is to include new materials, equipment, and methods of construction as well as those already in use.

A general statement outlining the objectives, procedure, and scope of the program, and known as Letter Circular LC502, Research Program on Building Materials and Structures 1937–1938, may be obtained by writing directly to Dr. H. L. Dryden, Bureau of Standards, Washington, D.C.

PWA AND WPA

PWA officials privately agree that PWA may really be nearing the end of its days as a spending or pump-priming agency. Plans are actually being made to gradually reduce its activities to the point where they may be handled by a skeleton organization.

It is more or less generally believed that the expenditure of the larger appropriations is likely to be continued by established departments and permanent agencies through which demands for federal funds are usually made. Since such activities are less obvious to the public eye, they are more likely to be continued and to contribute to an unbalanced national budget than might have been permitted among the temporary spending agencies.

Even though the Public Works Administration would not get additional funds, it still has $1,000,000,000 in unfinished projects and commitments to complete. While PWA may not make any more grants and loans, the organization is not likely to go entirely out of existence without further notice.

Section 206 of the Public Works Extension Act of 1937 bars the Public Works Administration from accepting applications on projects for the first time since June 16, 1933. More than 25,000 applications have been filed for projects involving over $7,000,000,000 in grants and loans and an estimated total construction cost in excess of $10,000,000,000. Less than one-half of those applications were approved but actual cost on work done appears reasonable in comparison with other phases of emergency construction.

Works Progress Administration appears to be the last of the emergency spending agencies which is open to applications for projects and in a position to accept additional financial responsibilities. WPA obligations are numerous, but it is still spending at an annual rate of $1,500,000,000.

Engineers have had much to do with CWA, FERA, and WPA, and while that organization, under the three names, has been eminently successful in doing what it set out to do—create immediate employment for the heads of relief families—many well-informed engineers objected when WPA invaded the construction field on "a force account" basis, and when it relieved the political subdivisions of their architectural and engineering work.

An excellent opportunity seems to be open to the Works Progress Administration to get out of the construction business. That could not be done abruptly, but it might be accomplished in reasonably good time. State and local engineering organizations and local sections of national engineering societies may perform a public service of national significance by encouraging local authorities to resume full responsibility for all public construction work in their respective communities.

ACTIVITIES OF COUNCIL

The Eighteenth Annual Assembly of the American Engineering Council and the Eighth Annual Conference of Secretaries of Engineering Associations, Clubs, Councils, Institutes, and Societies in the United States are scheduled for January 13, 14, and 15, 1938. The meetings are to be held at the Hotel Mayflower in Washington, D.C. A number of problems of common concern to the engineering and allied technical professions are being considered by the committees, and the programs, with the All Engineers' Dinner, are expected to hold unusual interest for all branches of engineering.

A meeting of the committee on the merit system of American Engineering Council was held in New York, September 16, on the call of Chairman R. L. Sackett. There were present Messrs. Berrlsford, Bishop, Henline, and Hoyt of the committee and F. M. Feiker, ex officio. The committee concurred in the idea of devising ways and means of forwarding the merit system by preparing a plan of procedure whereby state and local societies could sponsor the merit system for employment of engineers in states and municipalities as well as to continue to forward, in the public interest, the general desirability of merit as a basis for federal employment.

Washington, D.C.
October 1, 1937

News of Local Sections

Scheduled Meetings

BUFFALO SECTION—Luncheon meeting at the Buffalo Athletic Club on Nov. 9, at 12:15 p.m.

CENTRAL OHIO SECTION—Luncheon meeting at the Chittenden Hotel on Nov. 18, at 12:00 m.

CLEVELAND SECTION—Luncheon meeting at the Chamber of Commerce on Nov. 9, at 12:15 p.m.

IOWA SECTION—Annual meeting at Ames, Iowa, on the afternoon and evening of Nov. 18.

KANSAS CITY SECTION—Dinner meeting at the University Club on Nov. 9, at 6:30 p.m.

LOS ANGELES SECTION—Dinner meeting on Nov. 10, at 6:15 p.m.

METROPOLITAN SECTION—Joint meeting on welding at the Engineering Societies Building in New York City on Nov. 17, at 8:00 p.m.

MID-SOUTH SECTION—Business meeting at Greenville, Miss., on Nov. 5 and 6.

NASHVILLE SECTION—Dinner meeting in Kissam Hall at Vanderbilt University on Nov. 2, at 6:30 p.m.

PHILADELPHIA SECTION—Dinner meeting at the Engineers' Club on Nov. 17, at 6:00 p.m.

PITTSBURGH SECTION—Monthly meeting at the William Penn Hotel on Nov. 8, at 8:00 p.m.

SACRAMENTO SECTION—Luncheon meeting every Tuesday at the Elks Club at 12:10 p.m.

SAN DIEGO SECTION—Dinner meeting at the Diner Cafe on Nov. 18, at 6:30 p.m.

SAN FRANCISCO SECTION (Junior Forum)—Meeting at the Engineers' Club on Nov. 16.

ST. LOUIS SECTION—Annual meeting at the Statler Hotel on Nov. 20, at 6:30 p.m.

TENNESSEE VALLEY SECTION—Dinner meeting of the Knoxville Sub-Section at the University of Tennessee Cafeteria on Nov. 4, at 6:15 p.m.

TEXAS SECTION—Luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on Nov. 12, at 12 m.; luncheon meeting of the Dallas Branch at the Dallas Athletic Club on Nov. 1, at 12:15 p.m.

Recent Activities

BUFFALO SECTION

On September 24 members of the Buffalo Section enjoyed a golf tournament and dinner, which took place at the Park Country Club. When dinner was over George S. Minniss, president of the Buffalo Section and chief engineer of the Buffalo Grade Crossing and Terminal Station Commission, presented prizes for the best golf and made announcements of the Section's fall activities. The other after-dinner speakers were A. E. Horst, chairman of the Construction Division of the Society, who showed stereopticon slides of tunnel construction on the Buffalo intercepting sewers; and Edward P. Lupfer, Acting President of the Society, who gave a brief report on the semicentennial celebration of the Engineering Institute of Canada and discussed plans for the forthcoming Fall Meeting of the Society. There were 40 present.

CLEVELAND SECTION

The Cleveland Section held its first meeting of the season on October 3 in the Colonial Room of the Chamber of Commerce. Off to a good start, the members turned out well to hear C. C. Chambers, chief engineer of the Muskingum Watershed Conservancy District, speak on the subject of "The Muskingum Watershed District—Its Objectives and Relationship to Similar Projects." This talk proved to be very interesting and enlightening.

KANSAS CITY (MO.) SECTION

There were 52 present at a dinner meeting of the Kansas City (Mo.) Section, which took place at the University Club on September 14. Following dinner, Thomas J. Seburn, traffic engineer for Kansas City, spoke on the topic, "Traffic Engineering and Safety" stressing the engineer's rôle in the solution of traffic problems. Mr. Seburn's paper was ably discussed by Frank C. Lynch, director of the Safety Council. A smoker and social hour were enjoyed at the close of the technical program.

LOS ANGELES SECTION

Approximately 125 members and visitors were present at the September 15 meeting of the Los Angeles Section, which was held at the Friday Morning Club. Special guests included 22 young men from the University of Mexico, who are making a tour of inspection of construction projects in this country. Addresses were given by Henry A. Babcock, real estate economist, and Donald M. Baker, consulting engineer of Los Angeles. The former discussed the development of urban areas, while Mr. Baker spoke on the transportation problems facing the Los Angeles Metropolitan Area.

A meeting of the Junior Forum was held preceding the Section meeting. During this session members of the Forum reviewed the reports of Junior activities for other Sections, as published in the July issue of CIVIL ENGINEERING, and planned its activities and committee work for the ensuing year.

NASHVILLE SECTION

E. W. Bauman has resigned as president of the Nashville Section because of moving his home to Cleveland, Ohio. On October 3 the Section elected W. A. Coolidge as president, and S. A. Weakley as vice-president.

NORTHWESTERN SECTION

A dinner meeting of the Northwestern Section took place at the St. Paul Athletic Club on September 14. Preceding the meeting, an inspection tour was made of the construction of the sewage-treatment plant at Pig's Eye Island. A short report on the Local Sections conference, held in Ann Arbor, Mich., in July, was given by A. J. Duvall, who was delegate from the Section. He was followed on the program by C. C. Wilbur, the speaker of the evening. Mr. Wilbur, who is chief engineer of the Minneapolis-St. Paul Sanitary District, gave an interesting talk on the financing, construction, and operation of the Minneapolis-St. Paul Sanitary District Project. The attendance numbered 50.

PORTLAND (ORE.) SECTION

A joint meeting of the Portland (Ore.) Section and the Professional Engineers of Oregon was held in the Public Service Building in Portland on September 23. There were approximately 100 present to hear Glen H. Smith, speaker of the evening. Mr. Smith, who is engineer of outside construction of the Seattle, (Wash.) Lighting Department, used colored lantern slides to illustrate his talk on the source of Seattle's light—the hydroelectric developments on the Skagit River. Then Paul Trueblood, designer of the proposed Ruby storage dam, discussed some of the technical problems involved in the design of that structure. After the meeting refreshments were served.

PROVIDENCE SECTION

The first meeting of the season of the Providence Section was held in the Soils Laboratory of the U. S. Engineer Office on September 30. A talk on soil mechanics was given by Waldo I. Kenerson, chief of the Soils Laboratory of the U. S. Engineer Office, who stressed the need for cooperation between civil engineers and soil technicians. Following his talk, an inspection tour of the laboratory was made, and the tests to determine the physical properties of soils were demonstrated. There were 24 present.

ROCHESTER SECTION

Twenty-one members of the Rochester Section gathered for a dinner meeting at the Central Y.M.C.A. on October 4. Following dinner there was a business session, during which many matters of interest to the Section were discussed. The chairmen of several committees also gave reports. Members endorsed the editorial stand taken by a local paper in suggesting the employment of a traffic engineer, and seconded a motion to the effect that other Local Sections in the western part of the state be invited to attend a joint meeting at some central location.

SACRAMENTO SECTION

Following its usual custom, the Sacramento Section continued to hold weekly luncheon meetings during September. On the 7th, A. N. Johanson gave a talk on Sacramento's new fire-alarm system. There were 44 present. "Standard Typical Sections for Modern Highways" was the subject of an interesting paper presented on the 14th. The author of this paper was Fred J. Grumm, engineer of surveys and plans for the California State Division of Highways. The attendance numbered 62. On September 21, there were 61 present to hear Martin H. Blote, assistant hydraulic engineer in the California State Department of Public Works, who gave an illustrated lecture on "Harnessing the Mud Flow of Mount Shasta's Glaciers." The 47 members and guests in attendance at the meeting held on September 28 enjoyed hearing H. B. Walker, professor of agricultural engineering at the University of California, discuss the subject of "Heating Citrus Orchards for Protection from Frosts."

SAN DIEGO SECTION

The September meeting of the San Diego Section took the form of a dinner held at the Diner Cafe on the 23d. Following dinner C. P. de Jonge, of the San Diego Gas and Electric Company, presented a motion picture showing the laying of a 6-in. cast-iron gas main across San Diego Bay. After the motion picture, the regular monthly business meeting of the Section was held, at which such topics as mapping, engineers' salaries, and various Local Section problems were discussed. There were 10 present.

ST. LOUIS SECTION

On September 7 the first regular luncheon meeting of the St. Louis Section took place at the Hotel Mayfair, with 48 present. On this occasion the program consisted of a talk by F. W. Green, vice-president of the St. Louis Southwestern Railway Lines, who gave an informative talk on the meaning and purpose of the Missouri Society of Professional Engineers. These remarks were amplified by E. W. Carlton, professor of structural engineering at the Missouri School of Mines and Metallurgy, who has just been elected president of this society. A lively discussion followed from the floor.

SOUTH CAROLINA SECTION

The summer meeting of the South Carolina Section took the form of a two-day session held at Clemson Agricultural and Mechanical College of South Carolina on July 16 and 17. The technical program presented on this occasion consisted of talks by the following: F. H. H. Calhoun, dean of the school of chemistry and geology at the College, whose topic was "The Mineral Resources of South Carolina"; H. A. Smith, state forester, who discussed the forest resources of the state; James E. Gibson, manager and engineer of the Charleston Commissioners of Public Works, whose subject was "Tunneling Twenty-Six Miles Through Marl"; and Wilbur S. Smith, traffic engineer of the South Carolina State Highway Department, who spoke on highway safety and planning.

Hawaii a New Section

UPON prescribed application by interested members living in Hawaii, the Board of Direction on October 4, 1937, approved of and constituted a new Local Section to be known as the Hawaii Local Section. This is the third and most distant Section to be established by the Society outside of the continental United States. The other two are in Puerto Rico and Panama.

It is interesting to note that the recent inauguration of air service in the Pacific as well as in the Caribbean has brought distant Sections into relatively close and intimate contact with the Society.

Student Chapter Annual Reports

For the School Year, 1936–1937

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

The Agricultural and Mechanical College of Texas Student Chapter reports that the past school year was one of unusual interest and activity. On October 27 the Chapter was host to several well-known guests at a banquet given in the college dining hall. Among these were F. C. Bolton, dean of the college of engineering; F. E. Giesecke, director of the Texas Engineering Experiment Station; and the late J. M. Howe, consulting engineer of Houston, all of whom spoke. Entertainment at the other 13 meetings consisted of the showing of the Society's illustrated lectures and talks by students, members of the faculty, and outside speakers. The latter included E. P. Arneson, Director of the Society, and A. C. Love, resident engineer for the Texas State Highway Department. On one occasion M. W. Long, secretary of the American Concrete Pipe Association, showed pictures depicting the manufacture of concrete pipe, and on May 20 the annual farewell banquet took place.

ANTIOCH COLLEGE

During the past school year the Antioch College Student Chapter held eight meetings, with an average attendance of 15. At one of these sessions Royal Weller, of the Ohio State University Engineering Experiment Station, spoke on "Photoelastic Methods of Stress Analysis." The business of the Chapter and plans for the coming year were discussed at some of the sessions, and on one occasion a student program was enjoyed.

ALABAMA POLYTECHNIC INSTITUTE

In its annual report the Alabama Polytechnic Institute Student Chapter states that the past year has been one of unusual activity for the Chapter. Seven programs were devoted to student talks, all of which proved to be very interesting. On other occasions there were outside speakers—among them R. E. M. Des Islets, captain, Corps of Engineers, U. S. Army, and G. N. Mitcham, director of soil erosion control work for the state of Alabama. On April 2 and 3, 1937, the Chapter was host to the annual convention of the Southeastern Conference of Student Chapters. Many distinguished engineers attended the conference, and the entertainment for the occasion included a tea dance, a banquet, an inspection trip to Martin Dam, and an engineers' ball.

CALIFORNIA INSTITUTE OF TECHNOLOGY

Several inspection trips and social gatherings, in addition to a number of technical meetings, made the past school year an unusually interesting one for the California Institute of Technology Student Chapter. During spring vacation Prof. Franklin Thomas

GROUP FROM CALIFORNIA INSTITUTE OF TECHNOLOGY STUDENT CHAPTER VISITS THE METROPOLITAN AQUEDUCT PROJECT

arranged for a three-day field trip to the Metropolitan Aqueduct now under construction. Members of the Chapter were greatly interested in the various features of this huge project, which is being built by the Metropolitan Water District of Southern California. The accompanying photograph shows some of the students in oil skins about to enter San Jacinto Tunnel. Inspection trips to the Glendale flood-control project as well as through Los Angeles Harbor by boat were also enjoyed. In April the Chapter sponsored an "engineering open house," and in May it acted as host to the Los Angeles Section at a dinner in Dabney Garden.

BROWN UNIVERSITY

Outside speakers were present at three of the six meetings held by the Brown University Student during the past school year. These were Mason J. Young, lieutenant colonel, Corps of Engineers, U. S. Army, who gave an illustrated talk on flood-control work; Harry T. Immerman, chief engineer of Spencer, White and Prentis, New York City, whose topic was "Foundations and Underpinnings"; and Ole Singstad, chief engineer for the New York City Tunnel Authority. The other sessions were of an organizational or business nature.

BUCKNELL UNIVERSITY

Members of the Bucknell University Student Chapter found it profitable to cooperate with the other engineering societies on the campus in holding meetings during the past school year. In addition, the Chapter enjoyed six meetings of its own and sent representatives to the Annual Meeting of the Society, held in New York City in January, and to the Student Chapter convention at Villanova College in April. Among the social activities was the John T. Fetherston annual picnic, which took place on May 28.

CASE SCHOOL OF APPLIED SCIENCE

Full enrolment of those eligible for membership in the Case School of Applied Science Student Chapter is noted in the annual report for the past school year. In addition to monthly technical meetings, there were several business sessions. Outside speakers were scheduled for most of the technical programs, the list including J. M. Belknap, engineer for the U. S. Engineer Office in the Zanesville (Ohio) District; Dr. Volmar Fellenius, dean of civil

STUDENT CHAPTER MEMBERS AT THE CASE SCHOOL OF APPLIED SCIENCE

engineering at the University of Stockholm; Daniel W. Mead, then President of the Society; George B. Sowers, consulting engineer of Cleveland; and W. E. Wickenden, president of the Case School. In May the Chapter entertained the Cleveland Section of the Society and the Student Chapters at the University of Akron and Ohio Northern University at a joint dinner meeting.

CARNEGIE INSTITUTE OF TECHNOLOGY

The past year was a banner one for the Carnegie Institute of Technology Student Chapter. There were 32 meetings, half of which were in the hands of senior-class members of the Chapter who presented papers. The list of those who addressed the other sessions included W. S. Nathan, general manager of the Construction Specialties Company; E. H. McDermott, an engineer for the Rust Engineering Company; Arthur G. Butler, manager of engineering and construction for the Duquesne Light Company; J. F. Laboon, Contact Member for the Chapter; L. B. Duff, chief engineer for the Allegheny County Department of Works; and Paul W. Davis, design engineer for the Wichert Continuous Bridge Corporation. In October members of the Chapter attended the Fall Meeting of the Society, which was held in Pittsburgh, and in April they were guests of the Pittsburgh Section. During the year, several social and athletic events were held jointly with the University of Pittsburgh Student Chapter. There was 100 per cent enrolment of those eligible for membership.

CATHOLIC UNIVERSITY OF AMERICA

Illustrated lectures furnished by the Society were presented at a number of the 18 meetings held by the Catholic University of America Student Chapter during the past academic year. Talks by students and outside speakers were enjoyed at the other sessions. Among the latter were Walter E. Jessup, Field Secretary of the Society; Ralph W. Berry, Contact Member for the Chapter; Ernest Schuster, of the U. S. Geological Survey; T. Alfred Fleming, director of conservation for the National Board of Fire Underwriters; and Joseph Barnett, senior highway design engineer of the U. S. Department of Agriculture. There was 100 per cent enrolment in the Chapter.

CLARKSON COLLEGE OF TECHNOLOGY

An eight-day trip to New York City and its environs was the high light of the 1936–1937 school year for the Clarkson College of Technology Student Chapter. On this trip, which was made in the spring, members had an opportunity to view the Ward's Island sewage-disposal project and the Williamsburg Housing Project in Brooklyn and to take a trip around Manhattan Island and along the New Jersey coast in a government launch. Members of the Chapter also made a trip to Ottawa, Canada, where they inspected the filtration plant. There were six technical meetings during the year, with a total attendance of 100.

CLEMSON AGRICULTURAL AND MECHANICAL COLLEGE OF SOUTH CAROLINA

Students presented papers at 14 of the 17 meetings enjoyed by the Clemson Agricultural and Mechanical College of South Carolina Student Chapter during the past school year. At other sessions the Society's illustrated lectures were shown, and there were several outside speakers. In May the annual Student Chapter banquet took place at the Clemson Grill.

COLUMBIA UNIVERSITY

Students played an active part in making the 1936–1937 meetings of the Columbia University Student Chapter a success. In all, they presented 18 papers, all of which were well prepared and interesting. The list of outside speakers included Ernest P. Goodrich, Contact Member for the Chapter; Harold M. Lewis, engineer and planning consultant for the Regional Plan Association; T. Alfred Fleming, of the National Board of Fire Underwriters; and J. T. Meyer, of the Fairchild Aerial Survey Company. Members of the Chapter made an inspection trip to the Flushing Meadows, the site of the 1939 World's Fair, where they studied soil and foundation problems. At the end of the academic year Prof. J. K. Finch, Faculty Adviser for the Chapter, entertained the members with a buffet supper and dancing. There was complete enrolment of those eligible for membership.

COOPER UNION

The 1936–1937 meetings of the Cooper Union Student Chapter were made as varied as possible. Two of the six meetings were devoted entirely to student discussion. At the other sessions outside speakers discussed various engineering projects now under construction in New York City or its environs. In April members of the Chapter inspected the West Side Improvement Project. A detailed account of this trip and a photograph of the members making the trip appeared in the June issue of CIVIL ENGINEERING in this department.

CORNELL UNIVERSITY

A membership drive conducted by the Cornell University Student Chapter at the beginning of the 1936–1937 school year resulted in the largest membership on record. There were seven meetings, with a total attendance of 800. Except for two occasions when students presented papers, outside speakers were scheduled for all the meetings. The list included D. B. Steinman, consulting engineer of New York City; B. K. Hough, Jr., associate engineer in the U. S. Engineer Office at Ithaca, N.Y.; and A. E. Cummings, district manager of the Chicago office of the Raymond

Concrete Pile Company. On March 3 the Chapter and the Ithaca Section of the Society were joint sponsors of a dinner meeting at which Leon S. Moisseiff, consulting engineer of New York City, spoke on the construction of the San Francisco–Oakland Bay Bridge and the Golden Gate Bridge. Special activities included a two-day inspection trip to places of engineering interest in Buffalo, N.Y., and participation in the annual engineering show.

COLLEGE OF THE CITY OF NEW YORK

A fine schedule of technical meetings, inspection trips, and social events was enjoyed by the College of the City of New York Student Chapter during the past academic year. Students and outside speakers spoke at most of the 24 technical sessions, while on three occasions the Society's illustrated lectures were shown. Inspection trips were made to many important projects in New York City, including the sewage tunnel under the East River now under construction. The accompanying photograph shows a few members of the Chapter visiting the hydroelectric plant at Paterson, N.J. The Chapter participated in the annual engineers' open house and sponsored two supper dances, at which new members were initiated into the Society. The Chapter also edits *Tech News*, a three-page mimeographed weekly, which contains news of the Chapter and of the school of technology.

SEVERAL MEMBERS OF COLLEGE OF CITY OF NEW YORK STUDENT CHAPTER INSPECT THE HYDROELECTRIC PLANT AT PATERSON, N.J.

DREXEL INSTITUTE OF TECHNOLOGY

Outside speakers were present at all six of the 1936–1937 meetings of the Drexel Institute of Technology Student Chapter. Among these were V. F. Spring and J. M. McLoughlin, of the U. S. Engineer Office in Philadelphia; H. J. Whitten, superintendent of the Warner Company; J. L. Martin and H. Murphy, of the Philadelphia Rapid Transit Company, who showed a sound motion picture and slides on special street railway track work; Dr. J. E. Shrader, whose topic was "Photoelastic Stress Analysis"; and Dr. Rudolph Bernhardt, who discussed a method of stress analysis by induced vibrations. In January the Chapter acted as host to the Philadelphia Section of the Society for dinner and an inspection tour of the college, and in April it sponsored an engineers' ball. A party held at the Drexel Lodge at Newtown Square, Pa., concluded the year's activities.

DARTMOUTH COLLEGE (THAYER SCHOOL OF CIVIL ENGINEERING)

An engineering seminar was held in conjunction with the meetings of the Dartmouth College Student Chapter during the second semester of the past school year. In all, 15 student papers were presented, and one of them—that by Heston S. Hirst—was awarded the annual fifty-dollar prize given each year by the Thayer Society of Engineers for the best student paper. Outside speakers were present at some of the meetings, the list including Allan Coggeshall, of Hatzel and Buekler, New York City, and Revere G. Saunders, of the Fairchild Aerial Survey Company. Extracurricular activities included a fall outing and baseball games with other college teams.

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RECENT PHOTOGRAPH OF MEMBERS OF DARTMOUTH COLLEGE STUDENT CHAPTER

DUKE UNIVERSITY

There was full enrolment of those eligible for membership in the Duke University Student Chapter during the recently completed school year. Students presented papers at five of the 14 technical meetings, and several of the Society's illustrated lectures were also enjoyed. Special activities during the year included a smoker for the freshmen held jointly with local student groups of the other engineering societies; a joint meeting with the North Carolina Section of the Society; and sponsorship of the eleventh annual engineers' show, in which the other student groups also participated.

KANSAS STATE COLLEGE

Semi-monthly meetings were held by the Kansas State College Student Chapter during the past school year in conjunction with seminar engineering courses. Students, members of the faculty, and outside speakers cooperated to make the programs presented at these sessions interesting and varied. Outside speakers included President Mead; M. H. Davison, assistant engineer for the Kansas Division of Water Resources; E. M. Regier, assistant engineer of tests for the Kansas State Highway Commission; R. C. Mitchell, research engineer of the Kansas State Board of Health; and W. E. Baldry, Contact Member for the Chapter. Extracurricular activities included several smokers.

MEMBERS OF THE KANSAS STATE COLLEGE STUDENT CHAPTER

IOWA STATE COLLEGE

There was a total attendance of 4,080 at the 12 meetings held by the Iowa State College Student Chapter during the past year. Students, members of the faculty, and outside speakers cooperated to make the technical programs interesting. Among the latter were Bert Myers, head of the materials testing laboratory of the Iowa State Highway Commission; Maurice Miller, structural engineer and designer for Proudfoot, Rawson, Souers, and Thomas, of Des Moines, Iowa; President Daniel W. Mead; Maj. H. A.

SENIOR-CLASS MEMBERS OF IOWA STATE COLLEGE STUDENT CHAPTER ON INSPECTION TRIP TO CHICAGO

Skerry, who was engaged in administrative work on the Bonneville Dam; and C. Earl Webb, divisional engineer for the American Bridge Company. High lights of the year were the annual civil engineering open house, which attracted 2,000 visitors, and the usual senior inspection trip. This year the trip, which lasted a week, took the members to Chicago and to Gary, Ind., where they viewed numerous industrial projects and engineering improvements.

GEORGE WASHINGTON UNIVERSITY

A number of interesting programs were enjoyed by the George Washington University Student Chapter during the recently completed school year. The list of guest speakers included Field Secretary Jessup, who discussed matters of general Student Chapter interest; Morton Macartney, chief engineer of the Self-Liquidating Division of the Reconstruction Finance Corporation; William Bowie, retired hydrographic and geodetic engineer with the U. S. Coast and Geodetic Survey; Gen. R. C. Marshall, who described engineering construction experiences during the World War; and Lloyd V. Berkner, engineer and explorer, who gave an illustrated talk on his experiences with the first Byrd Antarctic expedition. The annual "mixer meeting" took place early in the fall, and the December and March meetings were given over to student programs. In February members of the Chapter participated in the annual engineers' ball.

GEORGIA SCHOOL OF TECHNOLOGY

Illustrated lectures loaned by the Society were enjoyed at five of the ten meetings held by the Georgia School of Technology Student Chapter during the past academic year. Among the outside speakers who gave talks at other sessions were L. F. Bellinger, Vice-President of the Society, and Searcy B. Slack, consulting engineer of Decatur, Ga. The latter also showed a motion picture on guard rails. In April the Chapter and the Georgia Section of the Society collaborated in holding a dance.

HARVARD UNIVERSITY

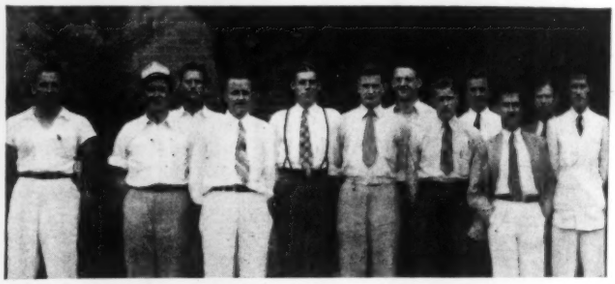
The past, and sixth, year of the Harvard University Student Chapter proved to be a very successful one. Several of the ten technical meetings were held in conjunction with meetings of the engineering societies in Boston. The list of outside speakers included S. G. Hibben, director of the Department of Applied Lighting of the Westinghouse Lamp Company; Stanley Kent, assistant chief engineer of locks and canals at Lowell, Mass.; L. K. Sillcox, president of the New York Air Brake Company; C. F. Goodrich, chief engineer of the American Bridge Company; and Mason J. Young and Hugh J. Casey, respectively lieutenant colonel and captain, Corps of Engineers, U. S. Army. Inspection trips were enjoyed to several places of interest—the Watertown Arsenal, the Boston Bridge Works in Cambridge, the plant of the New England Brick Company in Cambridge, and various engineering projects in New York City. The latter was a three-day trip. In May the Chapter joined the Harvard Engineering Society in giving a dinner in honor of Harald M. Westergaard, newly elected dean of the Harvard Engineering School. There was 100 per cent enrolment of those eligible for membership.

JOHNS HOPKINS UNIVERSITY

The Johns Hopkins University Student Chapter reports that it recently concluded one of the best years in its existence. Not only was there full enrolment of those eligible for membership, but the nine technical meetings attracted wide interest. In addition to members of the faculty, the following speakers were also heard: Melvin E. Scheidt, assistant to the state director of the PWA for Maryland; Field Secretary Jessup; Hale Walker, town planner for the Resettlement Administration; Clarence P. Taylor, director of the Maryland Highway Planning Survey; Abel Wolman, chief engineer of the Maryland State Department of Health; and Wesley Nelson, an engineer in the U. S. Bureau of Reclamation. The Chapter also sponsored an unusual number of field trips. A few of the places visited were the Greenbelt Resettlement Administration Project, the General Motors Assembly Plant, and the local plant of the Bethlehem Steel Company. In April the Chapter was host to the Second Annual Conference of Student Chapters in the region.

LOUISIANA STATE UNIVERSITY

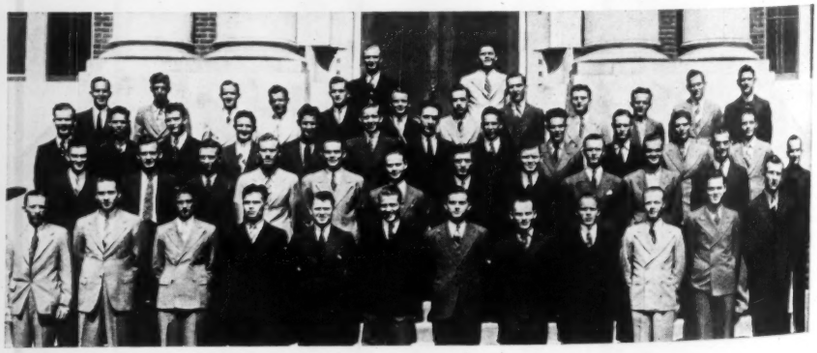
The Louisiana State University Student Chapter reports the close of the most successful year in its existence. In addition to holding 12 technical meetings, the Chapter sponsored a number of inspection trips to nearby points of interest and prepared and presented a civil engineering exhibit for the annual engineering day program. The special feature of this display was an observation station for observing the time stars as they cross the meridian. Among the speakers who addressed the meetings were L. C. Higbee, of the W. and L. E. Gurley Company; A. E. Crockett, of the Jones and Laughlin Steel Company; and President Mead.



SENIOR-CLASS MEMBERS OF THE LOUISIANA STATE UNIVERSITY STUDENT CHAPTER

MISSISSIPPI STATE COLLEGE

Although confronted with many organizational problems, the recently created Mississippi State College Student Chapter held ten meetings during the past school year. On these occasions papers were presented by students, members of the faculty, and outside speakers. The total attendance at the sessions num-



PRESENT PERSONNEL OF MISSISSIPPI STATE COLLEGE STUDENT CHAPTER

bered 426. The meetings were supplemented by visits to local construction projects and by trips to the Fall and Spring Meetings of the Society, which were attended by a number of the members.

LAFAYETTE COLLEGE

The Lafayette College Student Chapter reports that it held four meetings during the past year and that there was a total attendance of 60 at these sessions. On two of these occasions there were faculty speakers—E. H. Rockwell, Faculty Adviser for the Chapter as well as director of the department of civil engineering at the college, and Lynn Perry, assistant professor of hydraulic and sanitary engineering. Students were in charge of the other meetings.

LEHIGH UNIVERSITY

Several special activities made the 1936–1937 school year a memorable one for the Lehigh University Student Chapter. These were a Christmas banquet, a spring outing, an inspection trip to the McClintic-Marshall plant at Pottstown, Pa., and the annual senior inspection trip. The latter comprised a three-day visit to New York City, where the group inspected New York Harbor, the Midtown Tunnel, the Ward's Island sewage-disposal plant, and many other places and projects of interest. Several outside speakers were heard at the six technical meetings, the list including Field Secretary Jessup; E. L. Durkee, Contact Member for the Chapter and assistant engineer of the Bethlehem Steel Company; Charles Gilman, vice-president of the Massey Concrete Products Corporation; and Thaddeus Merriman, consulting engineer of New York City.

MICHIGAN COLLEGE OF MINING AND TECHNOLOGY

The high light of the 1936–1937 school year for the Michigan College of Mining and Technology Student Chapter was participation in the two-day engineering show held in May. The exhibits

MICHIGAN COLLEGE OF MINING AND TECHNOLOGY STUDENT CHAPTER IN FRONT OF SNOW BRIDGE BUILT DURING THE WINTER CARNIVAL

displayed by the Chapter included a model sewage-disposal plant, 6 by 12 ft in size, which attracted a great deal of attention. In the winter carnival the Chapter's entry was a large snow model of a concrete highway bridge, which was awarded second prize in the snow statue competition. An outing and steak supper cooked over an open fire concluded the year's activities. In all, there were nine meetings with a total attendance of 304.

MANHATTAN COLLEGE

There was full enrolment of those eligible for membership in the Manhattan College Student Chapter during the past academic year. Papers by students and the Society's illustrated lectures were the major feature of the programs presented at the 12 technical meetings. Several of the outside speakers who were heard during the year gave talks that tied into the field trips—as, for instance, that to the Chevrolet assembly plant at Tarrytown, N.Y. Another inspection trip that proved of interest was that to the steel plant of the Roebling Brothers. In May five representatives of the Chapter attended the Northeastern Regional Conference held at Rensselaer Polytechnic Institute in Troy, N.Y.

MARQUETTE UNIVERSITY

Nine technical meetings were held by the Marquette University Student Chapter last year. These sessions attracted a total attendance of 229. Inspection trips were made to the government housing project at Greendale, Wis.; the Kimberly Clarke paper mills at Kimberly and Neenah, Wis.; and the new sewage plant at Oshkosh, Wis. In December the annual joint banquet of the Chapter and the Milwaukee Section of the Society took place at the La Salle Hotel, and in the spring a picnic was enjoyed. Members of the Chapter were active in various athletic activities, especially bowling.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Motion pictures were enjoyed at a number of the eight meetings held by the Massachusetts Institute of Technology Student Chapter during the past school year. At the first meeting of the year, five official reels of the recent floods in Massachusetts were presented through the courtesy of the Massachusetts State Department of Public Works, and on another occasion an official film on Boulder Dam was shown by the U. S. Bureau of Reclamation. At one meeting, which was held in conjunction with sessions of other local student groups and the Boston Society of Civil Engineers, C. F. Goodrich, chief engineer of the American Bridge Company, gave an interesting illustrated lecture on the San Francisco-Oakland Bay Bridge.

NEW MEXICO STATE COLLEGE

Students, members of the faculty, and outside speakers cooperated in the presentation of technical programs at the 16 meetings held by the New Mexico State College Student Chapter during the past school year. Five of the Society's illustrated lectures were also enjoyed. Special activities included participation in the annual St. Patrick's Day engineering celebration, and a sixteen-day field trip. The latter included visits to many points of engineering interest in the South—Norris Dam, Wilson Dam, Chickamauga Dam, Wheeler Dam, Alcoa Dam, and the New Orleans Bridge, to mention a few. Over 4,500 miles were covered in the course of the trip.

GROUP OF MEMBERS OF NEW MEXICO STATE COLLEGE STUDENT CHAPTER

NEW YORK UNIVERSITY

During the past school year the New York University Student Chapter combined its eight technical and business meetings with smokers. The list of speakers for the technical sessions included Arthur G. Hayden, Contact Member for the Chapter; Alexander Haring, professor of bridge and railway engineering at the university; and Prof. Douglas Trowbridge, Acting Faculty Adviser for the Chapter. Members of the Chapter attended the Student Chapter Conference held at the time of the Annual Meeting of the Society as well as other events connected with the Meeting. The high light of the year was the Fourth Annual Spring Conference of the Metropolitan Conference of Student Chapters, to which the Chapter acted as host on April 24. A detailed account of this

SOME MEMBERS OF THE NEW YORK UNIVERSITY STUDENT CHAPTER

Conference appeared on page 425 of the June issue of CIVIL ENGINEERING. The accompanying photograph shows some of the members of the Chapter.

MONTANA STATE COLLEGE

Students played an unusually active part in making the 1936–1937 meetings of the Montana State College Student Chapter a success. They were in charge of the programs presented at the 25 meetings, and gave papers on various timely engineering topics

MEMBERS OF THE MONTANA STATE COLLEGE STUDENT CHAPTER

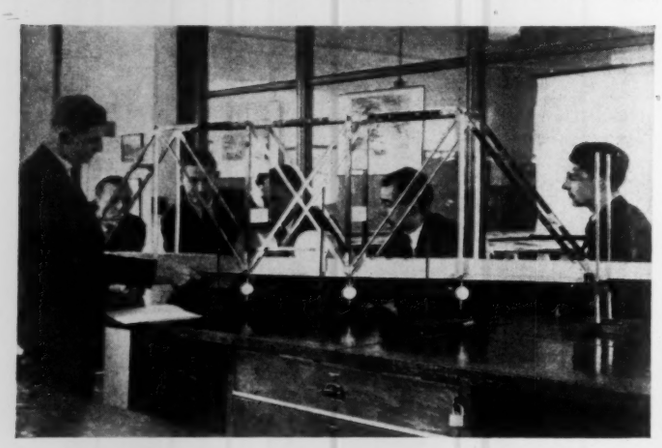
at each of these sessions. In May Field Secretary Jessup visited the Chapter and spoke on the history, aims, and organization of the Society. There was 100 per cent enrolment of those eligible for membership.

MICHIGAN STATE COLLEGE

Members of the Michigan State College Student Chapter presented 22 papers at the 1936–1937 meetings of the Chapter. Some of these papers, which covered a variety of timely technical topics, were prepared as part of a senior engineering seminar. The one outside speaker heard during the year was President Mead. In all, there were 14 meetings, with a total attendance of 220.

NEWARK COLLEGE OF ENGINEERING

A varied program of technical meetings, inspection trips, and social activities was enjoyed by the Newark College of Engineering Student Chapter during the past year. Six student papers were presented on the technical programs, and the following other speakers were also heard: Allan R. Cullimore, president of the college; W. H. Weiskopf, consulting engineer of New York City;



MODEL TRUSS EXHIBITED BY THE NEWARK COLLEGE OF ENGINEERING STUDENT CHAPTER AT THE ANNUAL OPEN HOUSE

Willem Rudolfs, chief of the department of sewage research at Rutgers University; Ole Singstad, chief engineer of the New York City Tunnel Authority; Harold F. Hammond, traffic engineer for the National Bureau of Casualty and Surety Underwriters; James E. Garratt, designing engineer for the Newark Water Supply Commission; and Harry T. Immerman, chief engineer of Spencer, White and Prentis, Inc. In February the Chapter participated in the annual engineers' open house. A model truss exhibited on this occasion is shown in the accompanying photograph. The annual father-and-son banquet was held in March.

NORTH DAKOTA STATE COLLEGE

During the past academic year the North Dakota State College Student Chapter held five meetings, with a total attendance of 175. The Society's illustrated lantern lectures were enjoyed at several

1936–1937 MEMBERS OF THE NORTH DAKOTA STATE COLLEGE STUDENT CHAPTER

of these sessions, and in April Edward Comm, district engineer for the WPA at Mandan, N.Dak., gave a short talk on the construction of dams.

NORWICH UNIVERSITY

The recently established Norwich University Student Chapter reports that it has made a good start in holding meetings and in planning a program for the coming school year. An illustrated talk on the Bethlehem Steel Company was presented at one of

MEMBERS OF THE NORWICH UNIVERSITY STUDENT CHAPTER

these meetings by a staff member of that organization, and a discussion on flood control occupied another session. At the final meeting of the school year motion pictures on the development of water power were shown, and officers were elected for the coming year.

OHIO NORTHERN UNIVERSITY

The Ohio Northern University Student Chapter reports 100 per cent enrolment of those eligible for membership in the 1936–1937 school year. The programs for the 18 meetings consisted of the showing of the Society's illustrated lectures and talks by students, members of the faculty, and outside speakers. Among the latter were L. H. Gardner, Contact Member for the Chapter, and Frank L. Gorman, then secretary-treasurer of the Cleveland Section of

RECENT PHOTOGRAPH OF SOME MEMBERS OF THE OHIO NORTHERN UNIVERSITY STUDENT CHAPTER

the Society. Special activities included participation in the annual engineers' week, which culminated in an engineers' ball, and an inspection trip to the Wheeling and Lake Erie Railroad locks under construction at Huron, Ohio. During the year the Chapter was transferred from the supervision of the Toledo Section to that of the Cleveland Section.

Missouri School of Mines and Metallurgy

During the recently completed school year the Missouri School of Mines and Metallurgy had 100 per cent enrolment of those eligible for membership. On the list of outside speakers at the 14 technical meetings were H. C. Beckman, Contact Member for the Chapter; H. A. Buehler, state geologist of Missouri; Paul S. Reinecke, major, Corps of Engineers, U. S. Army, and district engineer in the U. S. Engineer Office at St. Louis; William Stoecker, consulting engineer of St. Louis; and Richard S. Kirby, professor of engineering drawing at Yale University. At several of the sessions motion pictures were shown through the courtesy of the U. S. Department of Agriculture and the American Institute of Steel Construction.

Ohio State University

Eleven meetings were held by the Ohio State University Student Chapter during the recently completed school year. Varied pro-

1936–1937 Members of the Ohio State University Student Chapter

grams of student, faculty, and outside speakers were scheduled for these sessions, which attracted a total attendance of 356. The outside speakers were F. H. Waring, chief engineer of the Ohio State Health Department; Daniel W. Mead, then President of the Society; and the Reverend C. R. Garmey. Special activities included the annual smoker, held in the fall, and a farewell senior banquet in June.

Oklahoma Agricultural and Mechanical College

Several of the 12 meetings of the Oklahoma Agricultural and Mechanical College Student Chapter were devoted to discussion of student affairs and business matters. Members of the faculty

The Student Chapter at Oklahoma Agricultural and Mechanical College

spoke at several sessions, and two programs were presented by NYA entertainers. The exhibits that the Chapter entered in the engineering show held in the spring were specially commended.

Oregon State Agricultural College

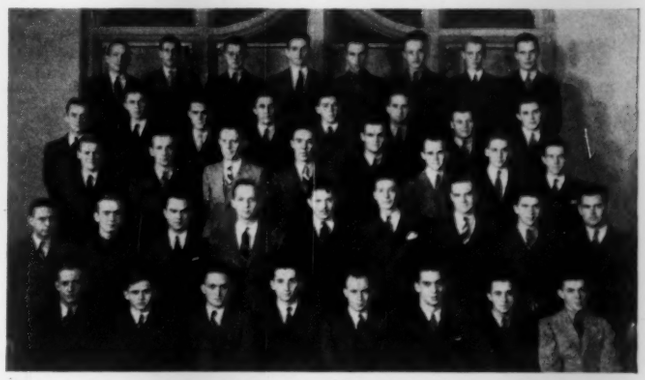
During the past year the Oregon State Agricultural College Student Chapter enjoyed an unusually well-rounded engineering and social schedule. The technical features of the year's activities consisted of nine regular meetings, inspection trips, and Sunday morning breakfasts, the latter proving of special interest to students and members of the faculty alike. Several meetings were held in conjunction with meetings of the Portland (Ore.) Section, and in May the Chapter arranged a special motor trip along the Oregon coast for Field Secretary Jessup. In the same month the Chapter sponsored the third annual engineers' day, which proved a great success. Social events included participation in the annual engineers' "bust" and dance, which took place in the fall.

North Carolina State College

The high light of the past school year for the North Carolina State College Student Chapter was participation in the annual engineers' fair, at which members of the Chapter exhibited various interesting engineering models. At the beginning of the year there was a smoker for prospective members, the feature of the occasion being the showing of the Society's illustrated lecture on the San Francisco–Oakland Bay Bridge. In all, there were ten meetings, with a total attendance of 234.

Purdue University

During the past school year the Purdue University Student Chapter held seven meetings, which attracted a total attendance of 980. Discussion of Chapter business occupied several of these sessions, and technical programs featuring outside speakers were presented at the rest. The list of these included M. R. Keefe, chief engineer of the Indiana State Highway Commission; Fred Kellam, engineer of design for the State Highway Commission; D. M. Simmons, chief consulting engineer for the General Cable



Members of the Purdue University Student Chapter for 1936–1937

Corporation, of New York City; C. E. Webb, division engineer for the American Bridge Company; and T. A. Dicus, new state highway commissioner. In October members of the Chapter enjoyed a two-day inspection trip to the Calumet industrial district as guests of the Indiana Section. Over 30 of the senior-class members of the Chapter applied for membership in the Society.

Polytechnic Institute of Brooklyn

There was full enrolment of those eligible for membership in the Polytechnic Institute of Brooklyn Student Chapter during the past academic year. A fine program of technical meetings and inspection trips made the year a notable one. Field trips were made to several of the reservoirs in the Metropolitan Area from which New York City draws its water supply; the steel fabricating shop of the Jones and Laughlin Company at Greenpoint, N.Y.; and the Rockville Center (N.Y.) sewage-treatment plant. The following speakers were heard during the year: B. M. Grover, assistant engineer of the Port of New York Authority; E. Warren Bowden, assistant to the chief engineer of the Port of New York Authority; Harry T. Immerman, chief engineer for Spencer, White, and Prentis, of New York City; H. A. Foster, acting chief engineer of design, New York World's Fair, Inc.; and Enoch R. Needles, Director of the Society and consulting engineer of New York.

Pennsylvania Military College

There was 100 per cent enrolment in the Pennsylvania Military College Student Chapter during the past year. Numerous inspection trips proved of special interest, the places visited including the Valley Forge cement plant, the Eddystone (Pa.) sewage-disposal works, and the Baldwin Locomotive Works at Chester, Pa. There were ten meetings, at which talks were given by students and outside speakers. Among the latter were C. E. Myers, Director of the

Society and consulting engineer of Philadelphia; Field Secretary Jessup; Joseph G. Shryock, vice-president, director, and chief engineer of the Belmont Iron Works; William Perkins, chief engineer and secretary of the Eastern Paving Brick Association; and Isaac S. Walker, consulting engineer of Philadelphia.

PENNSYLVANIA STATE COLLEGE

Publication of the *Penn State Tripod* was one of the interesting activities of the Pennsylvania State College Student Chapter during the past school year. This mimeographed sheet, which is issued about every two weeks, covers a great deal of college news. The Chapter had ten meetings during the year, the programs for these occasions being largely in the hands of students. The outside speakers were Robert Ridgway, Past-President of the Society; President Mead; and Jack Neubert, chief engineer of maintenance and ways of the New York Central Railroad.

RENSSELAER POLYTECHNIC INSTITUTE

The Rensselaer Polytechnic Institute Student Chapter reports that during the past year it held eight meetings, which attracted a total attendance of 900. Students were largely responsible for the technical programs presented on these occasions, although five outside speakers were also heard. Members of the Chapter attended the regional conference held at Rensselaer on May 8, 1937, as well as sessions of the Annual Meeting that took place in New York City in January.

PRESENT OFFICERS AND FACULTY ADVISER OF THE RENSSELAER POLYTECHNIC INSTITUTE STUDENT CHAPTER

PRINCETON UNIVERSITY

Several interesting outside speakers added interest to the seven meetings of the Princeton University Student Chapter during the past year. These were John M. Fitzgerald, vice-chairman of the committee on public relations of the Eastern Railway Presidents' Conference; R. E. Zimmerman, vice-president in charge of metallurgy and research of the United States Steel Corporation; E. E. Howard, consulting engineer of Kansas City, Mo.; Harold M. Lewis, engineer and planning consultant of the Regional Plan Association of New York; and C. F. Goodrich, chief engineer of the American Bridge Company. Visits were made to the General Motors assembly plant at Linden, N.J., and to see the Queen Mary at its dock in New York.

RUTGERS UNIVERSITY

Varied programs were presented at the nine meetings held by the Rutgers University Student Chapter during the past school year. In the fall an informal get-together was enjoyed, and later in the year the Chapter sponsored an illustrated lecture on the San Francisco–Oakland Bay Bridge, to which the other engineering societies at the university were invited. This lecture was presented by Blair Birdsall, junior engineer for the John A. Roebling's Sons Company. On another occasion the Chapter entertained the engineering faculty at a smoker. The year's social events included participation in the joint engineers' dance held in February.

RHODE ISLAND STATE COLLEGE

The 1936–1937 report of the Rhode Island State College Student Chapter shows for the past year an enviable record in increasing the membership 375 per cent over what it had been in the preceding year. Several outstanding speakers were scheduled for the technical programs, the list including Robert Ridgway, Past-President of the Society; Thaddeus Merriman, consulting engineer for the New York City Board of Water Supply; J. B. Babcock, professor of railway engineering at Massachusetts Institute of Technology; and E. Warren Bowden, assistant to the chief engineer of the Port of New York Authority. In May there was a joint meeting of the Chapter and other local student groups, and throughout the year members of the Chapter attended other engineering meetings in the vicinity of the college. In all, there were 12 meetings, with a total attendance of 670.

ROSE POLYTECHNIC INSTITUTE

Unusual interest in Chapter affairs was displayed by the members of the Rose Polytechnic Institute Student Chapter during the past year. In addition to eight technical meetings, there were several small inspection trips, and in November the senior members of the Chapter were guests of the Indiana Section of the Society for a two-day visit to several industries in the northern part of the state. In May the Chapter sponsored the showing of motion pictures of the actual construction of the George Washington Bridge before the whole student body. There was 100 per cent enrolment of those eligible for membership in the Chapter.

SOUTH DAKOTA STATE SCHOOL OF MINES

The Society's illustrated lectures were shown at five of the ten meetings held by the South Dakota State School of Mines Student Chapter during the past school year. Other sessions were devoted to discussion of Chapter business, with the exception of one occasion on which Harlan Erskine, assistant hydraulic engineer for the U. S. Geological Survey, spoke. Mr. Erskine's subject was stream gaging.

THE STUDENT CHAPTER AT THE SOUTH DAKOTA STATE SCHOOL OF MINES

STANFORD UNIVERSITY

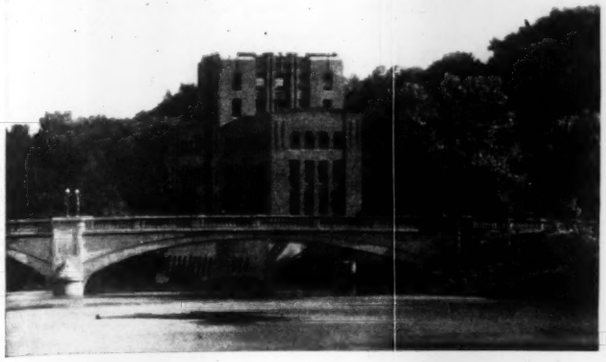
Monthly social meetings were enjoyed by the Stanford University Student Chapter during the past school year. Among the speakers heard on these occasions were Henry E. Riggs, at that time Vice-President of the Society; Benjamin Benas, sanitary engineer for the city of San Francisco; Charles Derleth, Jr., dean of the college of engineering at the University of California; Frank A. Kittredge, chief engineer for the National Park Service; and N. A. Bowers, Pacific Coast editor of the *Engineering News-Record*. In connection with trips made by the Four Founder Societies, the Chapter visited the two great bridges recently completed on San

STUDENT CHAPTER GROUP AT STANFORD UNIVERSITY

Francisco Bay and spent a week-end viewing the Hetch-Hetchy water development. The final meeting of the year took the form of a barbecue held at the home of Prof. Charles Moser.

STATE UNIVERSITY OF IOWA

Students played an active part in making the 1936–1937 meetings of the State University of Iowa a success by presenting a total of 36 papers during the year. The most notable outside speaker was Daniel W. Mead, at that time President of the Society, whose topic was "The Successful Engineer." The Chapter also took part in the twenty-eighth annual Mecca Exhibition, their display of hydraulic models being particularly admired. These exhibits were arranged in the hydraulic engineering laboratories shown in the accompanying photograph. A number of small inspection visits were made to various engineering projects in the city, and



HYDRAULIC ENGINEERING LABORATORY AT STATE UNIVERSITY OF IOWA

in May there was a special trip to view the engineering projects and industrial plants in several Iowa and Illinois towns.

SOUTH DAKOTA STATE COLLEGE

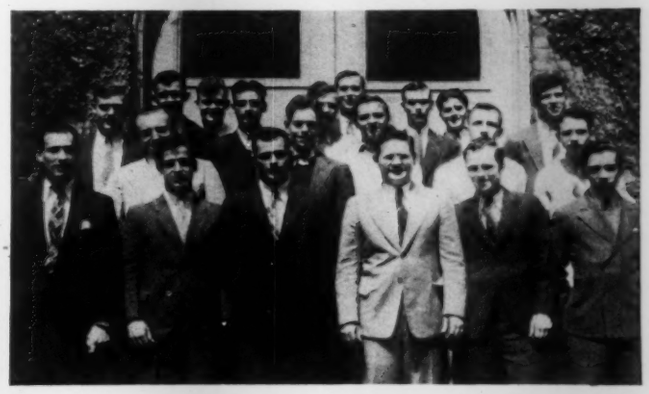
Students and members of the faculty were the speakers at all the 1936–1937 meetings of the South Dakota State College Student Chapter. There were nine meetings, with a total attendance of 256. Following each of these regular meetings, luncheon was served in one of the laboratories. On the occasion of all-college day, which is the annual spring open house for engineering exhibits, the Chapter displayed a number of interesting models. In October the Chapter helped celebrate "homecoming day" by entering a float in the annual parade. Other social events enjoyed by the members included a ball, which took place in March, and a smoker in April.

STATE COLLEGE OF WASHINGTON

Various types of illustrated lectures were presented at nine of the eleven meetings of the State College of Washington Student Chapter. On several occasions members of the U. S. Coast and Geodetic Survey gave illustrated lectures, and at other sessions the Society's lantern slide lectures were shown. In May a two-day inspection trip was made to the modern sewage-disposal plant at Walla Walla, Wash., and to Bonneville Dam, where the members were shown through the power house by B. E. Torpen, senior engineer on the construction of the project. The final gathering of the year took the form of a dinner, at which Field Secretary Jessup was guest of honor.

TULANE UNIVERSITY

The 1936–1937 school year was one of unusual interest and activity for the Tulane University Student Chapter. Not only was there full enrolment of those eligible for membership, but there were 34 technical meetings with a total attendance of 1,725. Some of the speakers who addressed these sessions were President Mead; C. G. Cappell, vice-president of the W. Horace Williams Company; George P. Rice, consulting engineer of New Orleans; A. A. Potter, dean of the college of engineering at Purdue University; L. E. Conrad, professor of civil engineering at Kansas State College; and W. F. Tompkins, district engineer for the Second New Orleans District. A large number of inspection trips



GROUP OF MEMBERS OF TULANE UNIVERSITY STUDENT CHAPTER

were enjoyed during the year, the list of places visited including the New Orleans plants of the Jones and Laughlin Steel Corporation and the Lone Star Cement Corporation, the New Orleans water works and purification plant, and the Bonnet Carré Spillway. Throughout the year special motion pictures of engineering projects were shown through the courtesy of various individuals and organizations.

UNIVERSITY OF CALIFORNIA

Monthly dinner meetings, a sports smoker, a field trip to the exposition grounds of the coming San Francisco World's Fair, attendance at the meetings of the San Francisco Section of the Society, and a highly successful membership drive comprised the 1936–1937 activities of the University of California Student Chapter. At the dinner meetings talks were given by members of the faculty, several prominent San Francisco engineers, and six students, the papers by the latter including all phases of their research and thesis work. The programs were further varied by the showing of motion pictures of construction work on the Wawona Tunnel and Santa Clara conservation system. In all, there

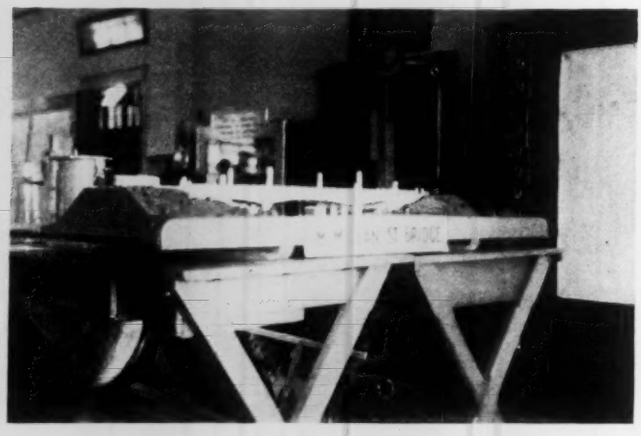
SENIOR CLASS MEMBERS OF THE UNIVERSITY OF CALIFORNIA STUDENT CHAPTER

were eight meetings, with a total attendance of 743. Various sports were enjoyed in inter-school competition.

UNIVERSITY OF CINCINNATI

The University of Cincinnati Student Chapter had 100 per cent enrolment of those eligible for membership during the past school year. Members of the faculty or outside speakers were

scheduled for all the technical programs. The list of these included Hunter W. Hanly, structural engineer of Cincinnati and chairman of the Committee on Student Chapters; and C. F. Goodrich, chief engineer of the American Bridge Company.



BRIDGE MODEL DISPLAYED BY UNIVERSITY OF CINCINNATI STUDENT CHAPTER ON ANNUAL "CO-OP DAY"

In April the Chapter held a joint supper meeting with the Cincinnati Section of the Society and, also, cooperated with the college of engineering in holding the annual "Co-op Day." Among the interesting exhibits displayed by the Chapter on this occasion was the bridge model shown in the accompanying photograph.

SWARTHMORE COLLEGE

The Swarthmore College Student Chapter functioned jointly with student branches of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers in holding semi-monthly meetings. At these sessions senior members of the Chapter presented 35 papers on various phases of the regular and research work of the engineering school. Several outside speakers were heard at special meetings, the list including E. J. Dent, colonel, Corps of Engineers, U. S. Army; C. R. Soderberg, of the Westinghouse Electric and Manufacturing Company; D. C. Prince, chief engineer of the Philadelphia works of the General Electric Company; and Field Secretary Jessup.

SYRACUSE UNIVERSITY

There was 100 per cent enrolment of those eligible for membership in the Syracuse University Student Chapter during the past school year. In all, there were ten meetings, with a total attendance of 300. Outside speakers at these sessions included Arthur G. Hayden, consulting civil engineer of New York City, and William F. Kavanaugh, deputy city engineer of Syracuse. The Society's illustrated lectures were enjoyed on two occasions, and on another a film showing the revetment work being done on the Mississippi was presented through the courtesy of the Asphalt Institute.

TEXAS TECHNOLOGICAL COLLEGE

Senior members of the Texas Technological College Student Chapter presented papers at all the 1936–1937 meetings of the Texas Technological College Student Chapter. In all, there were 24 of these papers, which covered a variety of timely engineering topics. On several occasions the Society's lantern lectures were enjoyed. As part of their regular academic work members of the Chapter prepared a number of interesting engineering models for exhibition in the annual engineers' show. The year's social events included a smoker, which was held in the fall, and a spring banquet.

UNION COLLEGE

Members of the faculty and outside speakers were scheduled for all the 1936–1937 technical meetings of the Union College Student Chapter. These included Burgess Johnson, professor of English at the college; the late Arnold Chapman, Contact Member for the Chapter; and Walter Baker, city manager of Rochester. The first meeting of the year took the form of a picnic at Prof. W. C. Taylor's farm, which was greatly enjoyed. In March the senior-class members of the Chapter went to Rochester, N.Y., where they visited various places of engineering interest.

UNIVERSITY OF AKRON

An inspection trip and several meetings comprised the activities of the University of Akron Student Chapter during the past school year. The trip was made to Dearborn, Mich., where members of the Chapter and of the local branch of the American Society of Mechanical Engineers were conducted through the Ford plant. Most of the meetings were devoted to a discussion of business matters, but at one session E. D. Barstow, Contact Member for the Chapter, spoke on engineering ethics.

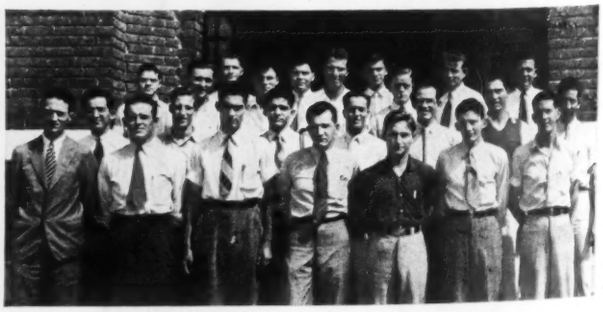
UNIVERSITY OF COLORADO

It is the custom of the University of Colorado Student Chapter to have each senior in the Chapter prepare two papers on engineering subjects—one for a seminar course, the other for Chapter meetings. In all, 22 such papers were presented at the 1936–1937 meetings of the Chapter. The list of outside speakers heard at other sessions included Frank Kimball, associate agricultural engineer of the U. S. Soil Conservation Service; Harry L. Potts, special engineer for the Denver Municipal Water Works; Francis M. Veatch, consulting engineer of Kansas City, Mo.; R. C Gowdy, Vice-President of the Society; and Field Secretary Jessup. In May several inspection trips were enjoyed, the places visited including Ralston Creek Dam, the Denver water and sewage-treatment plants, the Nebraska Bridge and Supply Company, and the Monolith Midwest Portland Cement Company (the two latter at Laramie, Wyo.).

MEMBERS OF THE UNIVERSITY OF COLORADO STUDENT CHAPTER

UNIVERSITY OF FLORIDA

Following its usual custom, the University of Florida Student Chapter sponsored the annual engineers' fair and field day during the past school year. A number of the eleven meetings that took place were devoted to discussion of and preparation for these events, and on other occasions members of the faculty and outside speakers were scheduled for the technical program. In March Lyle F. Bellinger, Vice-President of the Society, gave an



PHOTOGRAPH OF UNIVERSITY OF FLORIDA STUDENT CHAPTER TAKEN THIS FALL

interesting illustrated lecture on the practical aspects of civil engineering.

UNIVERSITY OF IDAHO

Special activities of the University of Idaho Student Chapter included publication of *The Rock Crusher*, the official monthly magazine of the Chapter. Each month the president of the Chapter appointed a new staff to work on this publication, thus ensuring valuable experience for all. In October the Chapter held a dinner meeting in honor of Dr. Charles Terzaghi, world authority in the field of soil mechanics, who spoke on his experiences in this country and in Europe. In May the Chapter held a joint meeting with the State College of Washington Student Chapter, and Field Secretary Jessup was present to give a talk at the last technical

GROUP OF MEMBERS OF THE UNIVERSITY OF IDAHO STUDENT CHAPTER

meeting of the year. Other activities of interest included inspection trips to Grand Coulee Dam and local engineering projects.

UNIVERSITY OF ALABAMA

Unusual interest in Chapter activities was displayed by the members of the University of Alabama Student Chapter during the past school year. Students were represented on six of the 14 programs presented. Among the outside speakers heard were W. H. Caruthers, Contact Member for the Chapter; H. H. Houk, chief engineer for the Alabama State Highway Department; L. F. Bellinger, Vice-President of the Society; A. C. Polk, consulting engineer of Birmingham, Ala.; and G. F. Vought, of the Portland Cement Association. The final meeting took the form of a joint session with the Alabama Section of the Society. On this occasion the Chapter presented Prof. John W. Leister, Faculty Adviser, with an engraved desk set as a token of appreciation of his interest in, and work for, the Chapter.

UNIVERSITY OF ARIZONA

A number of outside speakers were scheduled for the 1936–1937 meetings of the University of Arizona Student Chapter, the list including Louis O. Fiscel, county engineer of Pinal County; J. F. Mills, engineer of estimates for the Arizona State Highway Department; W. E. Dickinson, Contact Member for the Chapter; J. R. Van Horn, state manager of the Arizona Highway Planning Survey; and E. P. Conway, president of the Phoenix-Tempe Stone Company, of Phoenix, Ariz. The annual spring meeting, consisting of a luncheon, technical session, and dinner, was held jointly with a session of the Arizona Section of the Society. Special activities included a banquet and dance and an inspection trip to the Horse Mesa Dam, which was followed by a picnic.

UNIVERSITY OF ARKANSAS

Members of the University of Arkansas Student Chapter were very active during the past school year. As part of a senior seminar course, they presented 25 papers on a variety of timely engineering subjects. The first meeting of the year took the form of an informal get-together and smoker, and the last meeting was combined with the annual banquet. On this occasion the speaker was John H. Gardiner, district engineer of the U. S. Geological Survey at Forth Smith, Ark. In all, there were 18 meetings, with a total attendance of 434.

UNIVERSITY OF KANSAS

The University of Kansas Student Chapter reports the close of an interesting school year. The programs presented at the 11 meetings were interesting and varied, talks given by the students, members of the faculty, and outside speakers. On the list of the latter were Daniel W. Mead, then President of the Society; George M. March, Contact Member for the Chapter; George Davis, engineer in charge of construction of the grade-separation project

PRESENT MEMBERS OF THE UNIVERSITY OF KANSAS STUDENT CHAPTER

in North Lawrence, Kans.; and Earnest Boyce, director of the division of sanitation and chief engineer of the Kansas State Board of Health. In April the Chapter held its annual banquet and participated in the events of field day, and in May members of the Chapter went to Topeka to attend the joint meeting of the Kansas State Section of the Society and local Student Chapters.

UNIVERSITY OF KENTUCKY

Weekly meetings were enjoyed by the University of Kentucky Student Chapter during the past school year. Entertainment at these sessions, which attracted a total attendance of 1,320, was interesting and varied. Talks were given by students, members of the faculty, and outside speakers, and on four occasions the Society's illustrated lantern lectures were enjoyed. Activities

PHOTOGRAPH TAKEN THIS FALL OF UNIVERSITY OF KENTUCKY STUDENT CHAPTER

of special interest included an inspection trip to Louisville, Ky., and participation in the annual engineers' open house. Members of the Chapter were also instrumental in sponsoring a general celebration to commemorate the fiftieth anniversary of the engineering school. There was 100 per cent enrolment of those eligible for membership.

UNIVERSITY OF DAYTON

There was 100 per cent enrolment of those eligible for membership in the University of Dayton Student Chapter during the past academic year. Papers by students and outside speakers and the Society's illustrated lantern lectures were enjoyed at the 11 meetings. Several members of the Chapter attended all the meetings of the Dayton Section of the Society, and the Chapter

was host to the Section for its April meeting. Inspection trips were made to numerous projects of engineering and industrial interest in Dayton and Cincinnati as well as to the plant of the American Rolling Mills Company at Middletown, Ohio.

UNIVERSITY OF MAINE

During the past school year the University of Maine Student Chapter held six meetings, which had a total attendance of 123. Student papers were presented on several of these occasions, and at the others there were faculty or outside speakers. A trip was made to Saboomick Dam, where slides were made. Later these slides were shown at one of the meetings.

SOME OF THE MEMBERS OF THE UNIVERSITY OF MAINE STUDENT CHAPTER

UNIVERSITY OF MICHIGAN

Twelve meetings of the University of Michigan Student Chapter took place during the past school year. Among the speakers heard on these occasions were President Daniel W. Mead; Henry E. Riggs, at that time Vice-President of the Society; Mortimer E. Cooley, dean emeritus of the colleges of engineering and architecture at the University of Michigan; and A. E. Cummings, district manager of the Raymond Concrete Pile Company. Motion pictures were shown through the courtesy of the Republic Steel Corporation, and one of the Society's illustrated lantern slide lectures was also enjoyed. Special events included a smoker in the fall and the annual initiation banquet.

THE STUDENT CHAPTER AT THE UNIVERSITY OF MICHIGAN

UNIVERSITY OF DELAWARE

Several interesting outside speakers were heard at the 1936–1937 meetings of the University of Delaware Student Chapter. Among these were B. F. Hastings, president of the Philadelphia Section and district engineer for the American Institute of Steel Construction; E. C. Hartmann, research engineer for the Aluminum Company of America; Charles F. Mebus, consulting municipal engineer of Glenside, Pa.; and W. A. McWilliams, division engineer of the Pennsylvania State Highway Department for Kent County. There were seven meetings, with a total attendance of 195.

UNIVERSITY OF MARYLAND

The 1936–1937 annual report of the University of Maryland Student Chapter shows that there was 100 per cent enrolment of those eligible for membership during the past year. Programs presented at the 11 meetings were interesting and diverse, the speakers being recruited from the student body, the faculty, and the outside engineering world. Several of the Society's lantern slide lectures were also enjoyed. All the members of the Chapter attended the Student Chapter Conference at Johns Hopkins University in a body.

UNIVERSITY OF ILLINOIS

Outside speakers were heard at a number of the 15 meetings held by the University of Illinois Student Chapter during the past school year. On the list of these were John N. Chester, engineer of Pittsburgh, Pa.; L. D. Gayton, city engineer of Chicago; Albert Smith, president of Smith and Brown, engineers of Chicago; Joshua d'Esposito, PWA resident projects engineer for the Sanitary District of Chicago; Henry Penn, engineer for the American Institute of Steel Construction; A. E. Cummings, district manager for the Raymond Concrete Pile Company; and R. Bernhard, of the Baldwin-Southwark Corporation. Special social activities included a smoker, which was held in September, and the annual spring banquet, the last event of the year.

UNIVERSITY OF NEVADA

Several outside speakers were on the technical programs presented by the University of Nevada Student Chapter during the past academic year. Among these were Harry C. Dukes, who discussed the subject of water distribution in the Truckee River vicinity; Philip L. Inch, cadastral engineer in the Nevada Public Survey Office; A. R. Thompson, who commented on various phases of engineering; and Field Secretary Jessup, whose topic was Society affairs. In all, there were nine meetings, with a total attendance of 144.

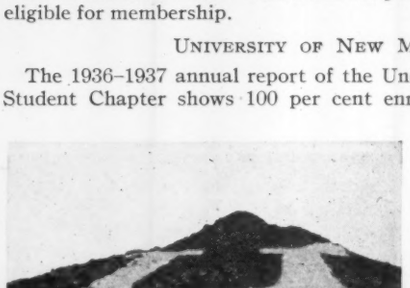
PHOTOGRAPH SHOWING MEMBERS OF THE UNIVERSITY OF NEVADA STUDENT CHAPTER

UNIVERSITY OF NEW HAMPSHIRE

Members of the University of New Hampshire Student Chapter played an active part in making their 1936–1937 meetings a success by presenting 66 papers, which covered many timely engineering subjects. In the fall a two-day inspection trip was made to the North Station of the Boston and Maine Railroad and the C. L. Berger Instrument Company in Boston, and to the Cape Cod Canal. In all, the Chapter held 21 meetings, which attracted a total attendance of 712. There was 100 per cent enrolment of those eligible for membership.

UNIVERSITY OF NEW MEXICO

The 1936–1937 annual report of the University of New Mexico Student Chapter shows 100 per cent enrolment of those eligible for membership. There were 14 meetings, with a total attendance of 292. At eight of these sessions students presented papers, and on three of these occasions the Society's illustrated lectures were shown. Other motion pictures were enjoyed through the courtesy of the Du Pont Company and the Tennessee Valley Authority. Extracurricular activities included the annual custom of "painting the U," shown in the accompanying photograph.



HUGE "U" PAINTED ON A HILLSIDE BY THE UNIVERSITY OF NEW MEXICO STUDENT CHAPTER

UNIVERSITY OF MINNESOTA

A concentrated and successful membership drive initiated the 1936–1937 activities of the University of Minnesota Student Chapter. During the year the Chapter sponsored the showing

of films, furnished through the courtesy of the United States Steel Corporation, and also a series of five lectures on the subject of employment. These were given by prominent engineers who outlined the possibilities in their particular fields and gave helpful advice for the future. Special activities included joint meetings with local student groups and with the Northwestern Section of the Society, participation in the annual engineers' day, and a spring picnic.

University of North Dakota

Students played an active part in the success of the 1936–1937 meetings of the University of North Dakota Student Chapter as they presented papers at seven of the nine meetings. On two occasions the Society's illustrated lantern lectures were shown, and on another M. W. Loving, of the American Concrete Pipe Association, gave an illustrated lecture on the use of concrete pipe. Exhibits entered in the annual engineers' day celebration included a complete working model of Fort Peck Dam. Field Secretary Jessup visited the Chapter in June.

Members of the University of North Dakota Student Chapter

University of Mississippi

Students presented papers at all 15 of the meetings held by the University of Mississippi Student Chapter during the past academic year. Several outside speakers were also heard, the list of these including George E. Riley, and Nelson H. Rector, respectively director and assistant director of the Mississippi State Board of Health; and J. A. LePrince, sanitary engineer for the U. S. Public Health Service. Films were shown through the courtesy of the U. S. Bureau of Mines and the General Motors Corporation.

University of Missouri

Several motion pictures were enjoyed by the University of Missouri Student Chapter during the recently completed school year. These were shown through the courtesy of the American Institute of Steel Construction and the Portland Cement Association. In November senior-class members of the Chapter were dinner guests of the St. Louis Section of the Society. In all, there were nine meetings with a total attendance of 318.

University of Nebraska

The Society's lantern slide lectures were enjoyed at a number of the 14 meetings held by the University of Nebraska Student Chapter during the past school year. On other occasions papers were presented by students and outside speakers. The high lights of the year were a field trip to Omaha, Nebr., a five-day inspection trip that took in many points of engineering interest, and participation in engineers' week and the annual field day contest. One of the meetings took the form of a smoker.

University of Oklahoma

The high light of the past school year for the University of Oklahoma Student Chapter was the annual St. Patrick's Day celebration and open house, in which the members entered a number of interesting exhibits. The float made by the Chapter for the annual parade in connection with this celebration also attracted a great deal of attention. Among the guest speakers appearing at the eight meetings were Thomas Banks, chief engineer of the Oklahoma City Water Department; Walter Burnham, chief engineer of the Oklahoma Conservation Commission; and B. S. Myers, consulting structural engineer of Oklahoma City. There was full enrolment of those eligible for membership.

University of Pennsylvania

During the past school year there was a marked increase in the membership of the University of Pennsylvania Student Chapter over other years. There were five meetings, with a total attendance of 112. The list of guest speakers present on these occasions included Julius Adler, Contact Member for the Chapter, and Solomon Swaab, consulting engineer of Philadelphia. Members of the Chapter have been present at many of the meetings of the Philadelphia Section, and in January the senior-class members of the Chapter attended the Annual Meeting of the Society in New York City.

University of Southern California

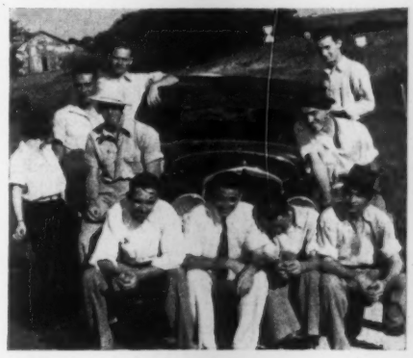
The University of Southern California Student Chapter reports that the 1936–1937 school year was unusually successful. Student papers, professional speakers, and the Society's illustrated lectures provided diversified technical meetings, and there were two inspection trips—one to Glendale, Calif., to study the government methods of flood control, and the other to the Cajalco Reservoir (at Arlington, Calif.), the main terminus of the Boulder Dam water supply to southern California. The list of outside speakers included Field Secretary Jessup, who discussed Student Chapter problems in general; Wiliam Fox, Contact Member for the Chapter; John Albers, city engineer of Glendale; and Edward Hyatt, state engineer of California. There was full enrolment of those eligible for membership.

University of Tennessee

The 1936–1937 annual report of the University of Tennessee Student Chapter shows that there were 12 meetings, with a total attendance of 144. The programs for these occasions scheduled talks by faculty members and several outside engineers.

University of Texas

A fine balance between educational and recreational activities was maintained by the University of Texas Student Chapter last year. In addition to 15 technical meetings, there were inspection trips to the site of Buchanan Dam and to places of engineering interest at San Antonio and New Braunfels, Tex. The Chapter displayed a number of interesting engineering models in the annual "power show" and also sponsored two open houses and smokers. During the Christmas season the Chapter cooperated with the faculty of the civil engineering department in giving a party for all civil engineering students, and in the spring it was host at another party and dance.



Senior-Class Members of University of Texas Student Chapter on Inspection Trip

University of Utah

The Society's illustrated lectures were enjoyed at a number of the 1936–1937 meetings of the University of Utah Student Chapter. Student papers were another feature of these occasions. In all, there were 17 meetings, which attracted a total attendance of 340.

University of Vermont

Although the University of Vermont Student Chapter was not established until January, its record for the second semester is very praiseworthy. The Society's lantern slide lectures were enjoyed at two of the seven technical meetings. The guest speakers heard on other occasions were Maj. Paul M. Ellman, of the Corps of Engineers, U. S. Army, and George Stanley, city engineer of Burlington, Vt. In the spring there were two inspection trips—one to the Comerford plant of the New England Power Association at Fifteen Mile Falls, and the other to the Little River Project at Waterbury.

University of Virginia

The 1936–1937 school year was an unusually successful one for the University of Virginia Student Chapter. Activities were initiated with a two-day inspection trip to the Tygart River Dam near Grafton, W.Va. The guest speakers heard at the meetings

held in the fall were Seth Burnley, city manager of Charlottesville, Va., and Field Secretary Jessup. After Christmas the meetings were devoted to preparations for the Student Chapter Convention, to which the Chapter was host in March. This highly successful event was followed by a tea dance. The final event of the year was an all-day picinic and inspection trip over the route of the Charlottesville water supply system.

UNIVERSITY OF WASHINGTON

Diversified programs were arranged for the 13 meetings of the University of Washington Student Chapter last year. There were student and outside speakers, and on five occasions the Society's illustrated lectures were enjoyed. In May the annual joint banquet with the Seattle Section took place, and there was also a joint technical meeting with the student branch of the American Society of Mechanical Engineers. On the latter occasion motion pictures of the construction of the San Francisco-Oakland Bay Bridge were shown through the courtesy of the Columbia Steel Company. Two-day field trips were made to Coulee Dam and to Seattle's municipal power development on the Skagit River.

UNIVERSITY OF WISCONSIN

Members of the faculty of the University of Wisconsin addressed several of the 1936–1937 meetings of the Student Chapter. On other occasions motion pictures were shown. In all, there were nine meetings, with a total attendance of 424. Social events included the Chapter's annual Christmas party and a spring picnic and baseball game.

UNIVERSITY OF WYOMING

There was 100 per cent enrolment in the University of Wyoming Student Chapter last year. Since no seminar course is offered in the engineering curriculum, the Chapter decided to utilize part of the nine scheduled meetings for the presentation of student papers and lectures. Four members of the faculty also spoke. At the last meeting of the year there were several outside speakers, including R. C. Gowdy, Vice-President of the Society; E. K. Nelson, Contact Member for the Chapter and city engineer of Laramie, Wyo.; and Field Secretary Jessup.

UNIVERSITY OF SOUTH CAROLINA

The annual report of the University of South Carolina Student Chapter states that there were 12 meetings in the 1936–1937 school year and that the total attendance at these sessions was 128. Business matters of interest to the Chapter were discussed at most of these sessions. A banquet, which was held at the Columbia Hotel in December, was especially enjoyed.

VANDERBILT UNIVERSITY

Motion pictures were shown at several of the 1936–1937 sessions of the Vanderbilt University Student Chapter. Those especially enjoyed were reels of an inspection trip to Chickamauga Dam made by members of the Chapter, a film contrasting New York City skyscraper architecture with the low, massive structures in Washington, D.C., and motion pictures of the work done at the Vanderbilt Engineering Camp. There were seven meetings, with a total attendance of 176. The last session of the year was a joint dinner meeting with the Nashville Section of the Society, the principal speaker on this occasion being Field Secretary Jessup. Smokers held in the fall and spring were greatly enjoyed.

VIRGINIA MILITARY INSTITUTE

During the past year the Virginia Military Institute Student Chapter held 20 meetings, the total attendance at these sessions being 1,600. Students were responsible for the programs presented on most of these occasions, as they gave 46 papers in all. On the list of outside speakers were E. M. Hastings, Contact Member for the Chapter; H. G. Shirley, commissioner of the Virginia Department of Highways; R. S. Phillips, of the Portland Cement Company; and J. C. Hoyt, consulting hydraulic engineer for the U. S. Geological Survey. There was full enrolment of those eligible for membership in the Chapter.

VIRGINIA POLYTECHNIC INSTITUTE

Students, members of the faculty, and outside speakers cooperated to make the 1936–1937 meetings of the Virginia Polytechnic Institute Student Chapter a success. In all, there were nine meetings, the total attendance at these sessions being 300. Special activities included participation in the annual engineers' day, a smoker in the fall, and the annual spring picnic.

UTAH STATE AGRICULTURAL COLLEGE

The Utah State Agricultural College Student Chapter reports the close of the most successful year in its existence. In addition to 13 meetings, there were many minor field trips to local places

UTAH STATE AGRICULTURAL COLLEGE STUDENT CHAPTER

of engineering interest, and in the spring senior-class members of the Chapter enjoyed a two-week trip that took in engineering projects in Washington, California, and Nevada. Outstanding social activities included a party in January and a formal St. Patrick's Day engineers' ball.

WASHINGTON UNIVERSITY

During the past academic year there was 100 per cent enrolment of those eligible for membership in the Washington University Student Chapter. Guest speakers were scheduled for the programs of most of the six technical meetings. In November the senior-class members of the Chapter were guests of the St. Louis Section of the Society at a banquet and technical session. The Chapter was also entertained at a smoker held at the home of Prof. E. O. Sweetser.

WEST VIRGINIA UNIVERSITY

Each member of the West Virginia University Student Chapter presented four papers at the 1936–1937 meetings of the West Virginia University Student Chapter. The Society's lantern slide lectures were also enjoyed on several occasions. In addition to holding 16 technical meetings, the Chapter made inspection trips to the Tygart River reservoir dam at Grafton, W.Va., and to Pittsburgh, Pa., and entered exhibits in the annual engineers' show. There was 100 per cent enrolment of those eligible for membership.

WORCESTER POLYTECHNIC INSTITUTE

The list of outside speakers appearing before the 1936–1937 meetings of the Worcester Polytechnic Institute Student Chapter included Field Secretary Jessup; E. Sherman Chase, consulting engineer of Boston, Mass.; and George Sanford, of the U. S. Bureau of Reclamation. Eight student papers and one of the Society's illustrated lectures were also enjoyed at these sessions. In all, there were seven meetings, with a total attendance of 260.

YALE UNIVERSITY

Numerous interesting activities supplemented the technical meetings held by the Yale University Student Chapter during the past school year. There were inspection trips to the plant of the Lone Star Cement Company at Hudson, N.Y., and to the new bridge under construction at Middletown, Conn. The Chapter contributed a great deal to the success of the two-day exhibit held by the Yale Engineering School in March, their displays including a complete working model of the Rocky River power development in the Housatonic Basin. On the list of speakers who addressed the technical sessions were Field Secretary Jessup; Charles E. Smith, vice-president of the New York, New Haven and Hartford Railroad; Ferdinand N. Menefee, professor of engineering mechanics at the University of Michigan; and Robert A. Cairns, city engineer of Waterbury, Conn. There was 100 per cent enrolment in the Chapter.

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for December

OVER fifteen papers, delivered at the Fall Meeting of the Society, held in Boston, Mass., on October 6–8, 1937, are scheduled to be abstracted or summarized in the December issue of CIVIL ENGINEERING. These papers cover such topics as soil mechanics and some of its applications, pollution problems in rivers and harbors, land registration and the plane-coordinate system in Massachusetts, aspects of economic and uneconomic public-works construction programs, pier construction and marine-borer hazards, and the necessity for thoroughfare and recreation planning in urban areas.

As complete a treatment will be accorded each paper as space limitations will permit. It is possible that some of the papers will be eligible for publication in full in PROCEEDINGS at a later date, and in these cases comparatively brief attention will be accorded them in CIVIL ENGINEERING. The disposition of each, however, will be determined through study by the Committee on Publications.

National Council of State Boards of Engineering Examiners Holds Convention

ON OCTOBER 11–13, 1937, the National Council of State Boards of Engineering Examiners held its eighteenth annual convention in Scranton, Pa. This meeting was attended by official delegates of 30 state boards and 10 national engineering societies. James L. Ferebee, M. Am. Soc. C.E., was the official representative of the Society. Secretary Seabury and Field Secretary Jessup also attended, and a number of Directors and other prominent members of the Society took part. The National Council is now composed of a membership of 38 legally constituted state boards, representing over 53,000 registered engineers and surveyors. (The executive secretary's report stated that three states—Georgia, Nebraska, and Texas—adopted engineering registration laws during the past year.)

The National Council adopted several minor amendments to its constitution and by-laws. One of the changes in the by-laws will permit the active secretary of a member board, although not a member of the board, to hold office in the National Council.

The National Bureau of Engineering Registration, which is a function of the National Council, has been given a trial operation for the past several years, and at the Scranton meeting it was put on a permanent basis by the adoption of a definite plan of procedure and requirements. The registration bureau will investigate, verify, and evaluate the professional records of registered engineers or engineers who are residents of states not having registration laws. Registered engineers meeting the minimum requirements of the model law may be issued a certificate of qualification, with reciprocal indorsement of their state board, and such certificates will be used in connection with reciprocal registration in the various states.

Reports of standing committees on accredited engineering schools, uniform examinations for registration, legal procedure, national bureau of engineering registration, and the constitution, were presented and discussed with much interest. A special committee on qualifying experience, with Dr. Charles F. Scott as chairman, was appointed to collect information on this important subject and report at the next meeting of the Council.

The annual banquet of the Council was well attended, and the honor guests were the officers or officially designated representatives of national engineering societies. Col. Willard T. Chevalier, of New York City, was the principal speaker and made an inspiring address.

The following officers were elected for the ensuing year: Prof. S. H. Graf, Corvallis, Ore., president; Dr. Charles F. Scott, New Haven, Conn., vice-president; J. O. Kammerman, Rapid City, S.D., director, Central Zone; and Col. C. E. Myers, Philadelphia, Pa., director, Northeast Zone. The other officers holding over are: Prof. J. S. Dodds, Ames, Iowa, past-president; K. C. Wright, Salt Lake City, Utah, director, Western Zone; and Prof. C. L. Mann, Raleigh, N. C., director, Southern Zone. T. Keith Legaré, of Colombia, S. C., was reelected executive secretary for his fourteenth term. Prof. J. S. Dodds, of Ames, Iowa, was appointed as one of the representatives of the National Council on E.C.P.D. Dean G. M. Butler, of Tucson, Ariz., and Virgil M. Palmer, of Rochester, N.Y., were reappointed members of the committee on national bureau of engineering registration. Messrs. Myers, Dodds, Wright, Mann, and Legaré are Members of the Society.

The next meeting of the Council will be held in Des Moines, Iowa, in October 1938. It was also tentatively decided to hold the 1939 convention in San Francisco, Calif., and the 1940 convention in Charleston, S.C. CIVIL ENGINEERING is indebted to Director Legaré for the account herewith.

Wise and Otherwise

AN EXPERIENCE of Professor Abercrombie which took place during his trip abroad some years ago has been called to the attention of the editor by William Trillow, who may be addressed at Leeds Hospital, Leeds, Mo.

When driving into the little-known principality of Deliria, the Professor had inadvertently failed to give the national salute by neglecting to shake his fist at the customs officer. The latter leaped into an official car and pursued Professor Abercrombie at a rate of 20 mph, Deliria's maximum speed limit in the open country. As the Professor drove at the same headlong speed, the customs officer was unable to do more than hold his own at a distance of 100 ft to the rear. The two cars soon approached a town, of which all in Deliria have a speed limit of 40 mph. They are laid out in the form of a square grid, four blocks each way, with entrances and exits at the corners of the grid.

Each car increased its speed to 40 mph on entering the town, maintained that speed to the city limit at the corner diagonally opposite, and there slowed down once more to 20 mph. Each car traversed 8 blocks from entrance to exit of the town—a total distance of 1½ miles. What distance separated the cars after both had emerged? How many different routes were at the Professor's disposal on entering?

In October's problem, three brides, Gretchen, Lisa, and Susan, went with their husbands, named (but not respectively) Peter, Jason, and Hans, to buy some pigs. Each person bought as many pigs as he or she paid shillings for each pig. Each husband paid a total of 63 shillings more than his wife paid. It was required to find how the couples were mated, if Hans bought 23 more pigs than Susan, and Peter 11 more than Gretchen. The solution, as given by H. E. Phelps, M. Am. Soc. C.E., who sent in the problem, is as follows:

The key equation is $X^2 - A^2 = 63$, where

X = number of pigs one man buys
A = number of pigs his wife buys

This equation has only three positive integral solutions, that is,

$$\left.\begin{matrix} X_0 \text{ equals } 8 \\ A_0 \text{ equals } 1 \end{matrix}\right\} \quad \left.\begin{matrix} X_1 \text{ equals } 32 \\ A_1 \text{ equals } 31 \end{matrix}\right\} \quad \left.\begin{matrix} X_2 \text{ equals } 12 \\ A_2 \text{ equals } 9 \end{matrix}\right\}$$

where the X's refer to the husbands and the A's to the wives, but where each set is not, as yet, assigned to the proper couple. But Hans buys 23 more pigs than Susan, and Peter buys 11 more pigs than Gretchen. By inspection, then, Hans and Susan must be represented by X_1 and A_2, Peter and Gretchen by X_2 and A_0, leaving X_0 and A_1 to represent Jason and Lisa. Assorting the couples then, as shown in the bracketed equations above, the matrimonial tangle, together with individual purchases of pigs, is resolved into

$$\left.\begin{matrix} \text{Peter } 12 \\ \text{Susan } 9 \end{matrix}\right\} \quad \left.\begin{matrix} \text{Hans } 32 \\ \text{Lisa } 31 \end{matrix}\right\} \quad \left.\begin{matrix} \text{Jason } 8 \\ \text{Gretchen } 1 \end{matrix}\right\}$$

Suggestions for other problems for Professor Abercrombie's column, accompanied by solutions, may be addressed to the editor. Solutions should preferably be sent in separate enclosed envelopes.

Are You Looking for Work?

A Personnel Counselor Suggests Methods in Technique of Locating Good Jobs

By WILLIAM L. FLETCHER

WILLIAM L. FLETCHER, INC., PERSONNEL MANAGERS AND COUNSELORS, BOSTON, MASS.

Sooner or later every engineer steps out to get himself a job. Whatever the cause—one's first position, the desire to try a different field, completion of a project, reorganization, a depression—one's campaign will benefit from taking the objective view of a personal situation that is frequently bewildering. The following article is packed full of sound common sense and practical, usable advice. Its author, William Leroy Fletcher, who graduated from Dartmouth in 1914, conducts a very successful personnel business in Boston, and speaks with authority in the field. Permission to reprint is gratefully acknowledged to the author and to the "Dartmouth Alumni Magazine," in the June 1937 issue of which it appeared.

HAVE YOU the problem of making the most of your life from an economic standpoint? Plainly, do you have to work for a living? If so, the first thing you must realize is that for the man of average or more than average ability, making good in business is 90 per cent a matter of starting right. This means getting into the right industry and the right company and the right job. Getting exactly the right job is quite different from simply getting a job.

Getting the right job is a sales problem. This is true regardless of your age, or the kind of position, or the salary you desire. You are going to sell yourself. You must be the sales manager, advertising manager, and salesman.

When you get the idea that you are not going to apply for something, but to sell your services, fixed in your mind, you will soon find yourself thinking of ways and means to secure the job you want.

This sales problem which you are facing can be divided into four parts:

1. The analysis of yourself to find out exactly what you have to sell.

2. The study of your market to determine who and where are your prospects, with particular attention to the tides or trends in business.

3. The planning of your campaign, that is, determining the best ways of establishing contacts with your prospects.

4. The execution of your campaign—establishing employer contacts and selling your services.

How do you do these things? First, you realize that in any job problem, the employer is the dominating factor. He has the job and he has the money. If you want his job and his money, you must get over on his side of the fence and find out what he needs and why. In selling, this is called getting the "you" attitude. "Contacts," so-called, are important things in getting jobs; but few men get jobs solely because of their "contacts." No employer is likely to hire you without giving the matter careful consideration for the simple reason that you are expensive If you are going to earn an average of only $50 a week for the next ten years, you will cost some employer $26,000. If he is a particularly able employer, this means all the profit on $260,000 of business. Obviously, nobody is going to spend that much money without careful consideration. It will help you in selling your services if you will realize at the outset that you have a high unit of sale and that the prospective employer has a right to ask you any and every question he may desire.

The employer who hires you will do so for only one reason—what he believes you can do for him. Compensation is a reward for services rendered. It is not a cause but an effect. So you may fairly say that you are not looking for a job, but some employer to whom you can render a valuable service.

Exactly what service can you render an employer?

This question is one which few can answer intelligently. Most men think that they know a great deal about themselves. As a matter of fact very few men know themselves. When a man has trouble in closing his prospects, or in arranging "contacts," or in writing letters that pull, the chances are four out of five that his trouble lies in his lack of knowledge of himself. Accurate self-analysis cannot be made in a slip-shod way; but there are tricks which can be used advantageously. Most large corporations use intelligent questionnaires. If you will secure the blanks of any half-dozen corporations and complete these blanks, you are almost certain to find before you have completed the last blank, that you have located the root of your trouble.

SUPPLEMENTARY INFORMATION NEEDED

It is not possible, of course, to get the measure of a man by asking questions. In analyzing yourself or in going after a position, supplementary information is most worth while. Prepare this as a part of an analysis of yourself. Use it as your good judgment dictates. Let this supplementary information contain complete information carefully paragraphed and captioned, covering:

1. Early environment—that is, the kind of home from which you come.

2. Scholastic activities—meaning the subjects in which you excelled, and also the ones you did not like.

3. Any work you did while attending college to earn money.

4. A tabulated list of the industries in which you have had experience.

5. Complete information regarding problems met and solved.

In studying your market, you should pay particular attention to two things: First, the probable growth or decline of various industries; and second, the management of various companies. It is much easier for a capable man to forge ahead in an industry which is expanding than it is in one which is stagnating or contracting. In the prosperous years immediately preceding the depression, 80 per cent of all profits were produced by 20 per cent of all employers. Behind this fact lies another fact which is even now not appreciated by too many people—profits come only through men and only the outstandingly capable men are today producing profits. In going after a job, you should try hard to get into a particularly well-managed company. Also you should consider the character of the managers of that organization—are they really willing to pay for results if, as, and when you can produce them?

In selling your services, letters are your most valuable tool. With a postage stamp and a little time, you can reach any employer in the country and tell him your story. If you write letters, do not ask yourself if they will go to the wastebasket, or be read. You do not ask yourself this question when you write to a personal friend or to any business man on any subject except getting a job. Write as you talk. Perhaps it would be better to say, "Don't write, but talk." Think what you would say to the employer if you were talking to him over the telephone. Write it down, sign it, and mail it.

Another tool which is little appreciated is a telephone canvass. If you are located in a large center, you can take a list of 100 employers, gleaned from the advertising columns of the newspapers and magazines and from the classified telephone directory, call each of them on the telephone, and ask for a job. You may stumble a bit the first two or three times you try this, but if you will call a hundred firms, you are almost certain to be agreeably surprised at the results.

When you meet an employer face to face tell him what he wants to hear so far as you can do so and be truthful. Particularly, try to show him that you are not just another cucumber in the cucumber patch. Speaking generally, most employers like men who are like themselves. If you are asked to submit a photograph submit a good one. You wouldn't think of putting out an automobile catalogue containing photographs of 1930 or 1925 automobiles. Don't show yourself as you were five or ten years ago and don't ever send a photograph except one taken with you looking straight into the camera.

Many outstanding successful men say that they are successful because of four factors. They work and study hard, but they have from someone else expert direction and intelligent criticism. Hard work and study today are not enough to insure success. Direction and criticism are also necessary. Stretch your mind. Keep it

elastic and active. Invest some of your margin—that is, the time when you are not working, eating, or sleeping—in keeping yourself alive and out of deadening ruts. If you do this well enough you can be the buyer of jobs rather than the salesman of your services. Results count.

Building the Golden Gate Bridge Depicted in Motion Pictures

A NEW motion picture entitled "Building the Golden Gate Bridge," just completed by the Bethlehem Steel Company, was released October 10, 1937. It is a talking picture with a descriptive lecture on the sound track. Beginning with the arrival of the steel on the bridge site, the picture gives a complete account of the construction of the bridge across the Golden Gate at San Francisco.

The huge steel towers, 746 ft high, that support the cables are seen to rise from their foundations as the steel is assembled and placed in position, and the construction of the superstructure for the roadway on the 4,200-ft suspended span is depicted in detail. Of particular interest are the many special methods required in handling the steel due to the great size of the structure. Many difficult problems had to be solved in the construction of the Golden Gate Bridge, and the methods used are discussed on the sound track of the picture.

Local Sections or Student Chapters of the Society may secure showings of the picture by writing to the Bethlehem Steel Company, Bethlehem, Pa., or by contacting any one of the company's district offices. It would of course be desirable to make requests as early as possible, but three or four weeks' notice will ordinarily suffice. No fee will be charged for use of the film, but questions of provision of a projection-machine operator and payment of transportation charges should be taken up with the company. The showing of the picture will occupy about 45 minutes.

An Unusual Summer Surveying Camp

By RALPH E. GOODWIN, M. AM. SOC. C.E.

ASSOCIATE PROFESSOR OF CIVIL ENGINEERING, COLLEGE OF THE CITY OF NEW YORK, NEW YORK, N.Y.

TECHNICAL schools usually conduct their summer surveying camps in the country upon tracts of land which are in a state of nature and are owned and controlled by the school. If the students remove their shirts while working, or park their cars where most convenient for themselves, it is not necessary for the camp director to call them to account or to make peace with an ever-watchful police force. But instead of turning its students loose, free from all responsibility upon its own exclusive grounds, the College of the City of New York conducts its surveying field work under practical working conditions in Van Cortlandt Park and on the streets surrounding it in New York City.

The park comprises more than 1,100 acres, so there are no limitations due to lack of space. The natural features include woods, fields, rough rocky hills, a stream, swamps, a lake, and even the requisite supply of poison ivy. The park is traversed by roads, parkways, and two railroad lines. The adjacent streets are monumented and numerous official city benchmarks are available, offering a much prized opportunity to familiarize the students with the practical features of city surveying.

Instead of being isolated in a small world of their own, where they can do no wrong, the students learn to work while subject to the hindrances, annoyances, and responsibilities of actual practice. Automobiles park in their lines of sight. Curious onlookers kick the legs of their tripods. Boys destroy their stations and benchmarks. Children beg, "Take my picture, Mister?" And efficient policemen watch to see that they keep their shirts on and respect the integrity of the park shrubbery, even when it interferes with their surveying operations. A sleeveless jersey or gym shirt is acceptable, but students who strip to the waist on hot days are wont to hear a blast from a "cop's" whistle, followed by, "Hey, put your shirt on! Where do you think you are—at the beach?" In justice to the students it should be said that they offend less in this particular than do the baseball players and other park visitors.

The control of large numbers of surveying students in a city park has presented some real difficulties. If stakes were driven in the lawns, it would be impossible to make sure that all of them were removed before the lawn mower struck them. This problem was solved by furnishing students with removable metal turning points to be used in place of stakes for leveling; and by marking transit stations by nails pushed through small squares of white cloth. Other similar difficulties have been encountered and successfully surmounted.

One of the principal problems still remaining is that of keeping triangulation lines cleared, once they have been established. The rank foliage of the park constantly invades lines of sight. The Park Department is very helpful, however, about permitting existing lines to be maintained. Its chief engineer cooperates with the school authorities in every possible manner. The fact that the College of the City of New York is a free college maintained by the city itself makes its summer surveying camps in effect one of the city departments. Many of its graduates find employment in the city service.

The City of New York coordinate system is based upon a fictitious meridian parallel to the avenue system of the Borough of Manhattan. Student topographic maps conform to this meridian, and the coordinates of student triangulation stations are computed in the City of New York system. Blueprints of the city record maps and coordinate record sheets are available for student use, and city monuments on Broadway furnish the tying-in points for bearings and coordinates. Five different base lines are used in triangulation, and an extensive triangulation system of connected networks provides the basis for topographic control.

Leveling is based upon the official city datum known as mean sea level. Van Cortlandt Park is located in the Borough of the Bronx, and the local borough datum is mean high water. The difference between the two datums is explained to students. The difference in elevation between the surface of the lake and the highest benchmark in the student survey system is 154 ft. This difference is adequate for demonstrating the technique employed in barometric leveling and in all other necessary operations.

HYDROGRAPHIC, TOPOGRAPHIC, AND CITY SURVEYING PROBLEMS ARE ENCOUNTERED IN A SINGLE CITY PARK AND ITS ENVIRONS

Something for the Undergraduate to Think About

By THOMAS H. EVANS, JUN. AM. SOC. C.E.
ASSISTANT PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF VIRGINIA, CHARLOTTESVILLE, VA.

MOST undergraduates have some day to think about employment, and the following observations were inspired by a statement made by an employer of many young engineers. He said that 25 per cent of a prospect's worth is judged on his scholastic record and the remainder depends on his personality and ability to work with his fellows. While these figures may not be average, they mean that ability to absorb knowledge and satisfactorily utilize it as an undergraduate simply makes the man eligible for employment of one kind or another. From that point on, the employer is principally interested to know whether he is getting good organization material—men who not only can work satisfactorily in a group, but who also will demonstrate possibilities of initiative and leadership. The ability to obtain a degree, even with honor standing, is no true measure of these all-important characteristics. Naturally, a man with a high scholastic, plus a good extracurricular record is the ideal any employer hopes to get.

Thus, since most organizations are looking for good material for their "team" rather than for individualists, let us scan the opportunities for such development in college. To me these opportunities exist in the many extracurricular activities. I feel qualified to express myself on this because of my intimate contact with many of them as an undergraduate less than ten years ago, a span of years not long enough to erase my appreciation of the student's viewpoint.

What, then, is the big advantage to a young man in joining and working with organizations on the campus? To the individual it is not that he carries on some noble tradition of dear old Siwash, but that in doing so he is improving himself. How? Because that man learns to carry, on his own, a certain amount of responsibility; he has a chance to exercise initiative and judgment; and he is working with a number of different temperaments towards a common goal. He has to express himself now and then to get ideas "across" to his colleagues. He may lead a committee and then, perhaps, the entire group. In other words, that man learns to do jobs of a type which society and employers will call upon him to do. He is taking advantage to the full of what a college education has to offer. The undergraduate's success as a useful citizen of the university will be a good yardstick of his attainments in later life.

This so-called "broadening" is of value especially to an engineering student because his normal training, of necessity, has to leave out many desirable cultural courses. If he is on a university campus, his work usually keeps him in a group of buildings where he can be almost self-contained. There is a tendency to crawl into this "hole" and pull down the cover. The line of least resistance leads to such a rut of self-satisfaction, to a spirit of contempt toward the liberal-arts student with an apparently easy schedule. But there are marvelous opportunities in such a case which a little initiative will enable a man to take advantage of. Here is a remarkable chance to mix with many types besides just engineers—fellows with many different slants on life with whom he can learn to converse and to get along, human beings from whom to extract ideas and culture. Unfortunately the man in a purely technical school will miss this particular advantage, but he still has his own organizations and colleagues to work with.

In case the reader wonders just what is meant by extracurricular work, let me state that it implies any activity from a reading club or debating team to a highly organized political group or athletic team—in fact any group banded together with a worth-while purpose in view. There is usually some activity to fit almost every personality. Some men can take only a taste here or there, while others can assume a great deal of responsibility in many things. How much a man should "bite off" depends on his own good judgment.

One important consideration, however, is not to overdo activities. You still have to obtain the old sheepskin. In fact, that comes first, and a man must strike between the two a happy medium which fits his own aptitudes. Those organizations that take a great deal of time, such as football, would naturally not be advisable for a man who is shaky in his studies, even if he has athletic prowess. A man's own judgment can be gaged by his ability to do well in classes and carry on a certain amount of organization work at the same time. Don't, however, try to be just a "big man on the campus" because you may find yourself looking for work without the diploma. But the man who excuses his inertia with the old bromide that he "hasn't time" usually fails to realize the large quantity of the precious stuff he wastes in "bull" or "gumming" sessions with the boys.

Personality, an important factor of that 75 per cent, is something a man inherits, but in a great many it is subdued and can only be developed by the assumption of responsibility and contacts with others. It is remarkable to watch the blossoming out of a young man who starts through the mill with a bad inferiority complex. In a few cases he forces himself to come out of his shell by the exercise of strong will power, or by advice gained from an inspiring book. In others quite often friends start him in organization work which he learns to enjoy. At any rate his personality is uncovered; the boy finds himself, and nothing should stop his progress.

Personnel men who interview young engineering applicants each spring are always very much interested in a man's extracurricular record. If they attach so much importance to it there must be something to be gained from such work.

Iowa State College Analyzes Status of Engineering Graduates

ENGINEERING students and young engineers in particular will find food for thought in the analysis recently made by Iowa State College of the status of its civil engineering graduates. The study is based on 251 replies to a questionnaire that was sent to alumni back to and including the class of 1910.

Tables I and II contain data concerning experience and advancement. The groups into which the men were classified are listed in the order of the number of replies received. In Table I are given, for each group, the average yearly increase in compensation and average length of employment. Table II shows the ranking of each group in respect to: (1) Salary increase; (2) college grades of the men in the group; (3) amount of technical reading and non-technical reading done after graduation; (4) self-improvement (an estimate of which is derived from various information in the replies); (5) number of men in the group who have secured their professional registration. The last column shows a composite ranking based on the rankings in the other columns.

The salary studies as reported in these tables show the increase in income for the total time out of college. While the results are representative for the entire period since graduation, and in comparing the various groups, they do not take into account the effect of the depression years.

A study made in October 1931, for the classes 1925–1931, showed only 35 per cent in public work. The present study, for groups of classes 1910–1919, 1920–1929, and 1930–1937, shows practically a uniform percentage, approximately 67 per cent, now in public work. The effect of the depression period seems definite in transferring many from private to public employ.

The questionnaire included the following request: "Describe how your employers have assisted in your progress by personal guidance, by training courses, by transfer to different types of work, by opportunity for increased responsibility, or by other means." In their replies, 61 men reported that they had received personal guidance, and 36 reported training courses given by employers. More than half reported transfers to different types of work and opportunity for increased responsibility. On the other hand, 13 reported that they had to make

their own responsibility without assistance.

"Employer guidance" of one sort or another was most common in Groups 10, 5, 8, and 2. It will be noted from Table I

TABLE I. DISTRIBUTION IN GROUPS, AND INCREASE IN INCOME AND LENGTH OF EMPLOYMENT

GROUP	NO. OF REPLIES	AV. INCREASE IN INCOME, %	AV. EMPLOYMENT, YEARS
1. Public construction*	32	7	4.3
2. Private construction	25	21	3.9
3. Public works†	43	9	3.1
4. Transportation (27 Hy.,‡ 5 Ry.)	32	8	8.0
5. Structures	30	13	7.3
6. Outside of civil engineering	25	11	5.0
7. Sanitary and hydraulic	19	9	3.7
8. Education and research	18	12	2.9
9. City and county work	16	7	4.5
10. Development and sales	11	12	3.4
Total and averages	251	10.7	4.6

* Mostly with highway commissions.
† U.S.E.D., P.W.A., W.P.A., C.C.C., State Planning Board, etc.
‡ Not including state men in highway construction.

that these four groups show the four highest salary increases, and that they are all within the five highest groups in regard to college grades. The rather definite relationships which seem to be established between scholarship, guidance after graduation, and financial recognition may be significant.

TABLE II. GROUP RANKINGS

GROUP	SALARY INCREASE	COLLEGE GRADES	TECHNICAL READING	NON-TECHNICAL READING	SELF IMPROVEMENT	REGISTRATION	COMPLETE RANKING
Public construction	10	10	9	10	7	4	9
Private construction	1	5	8	8	10	8	8
Public works	6	6	10	5	8	5	7
Transportation	7	8	6	7	2	2	5
Structures	2	2	5	2	6	6	4
Outside of civil engineering	5	9	7	9	9	10	10
Sanitary and hydraulic	8	3	2	4	3	7	2
Education and research	3	1	1	1	1	3	1
City and county work	9	7	4	3	4	1	3
Development and sales	4	4	3	6	5	9	6

Another interesting question was "To what extent have your employers encouraged or subsidized your attendance at technical society meetings or conventions, membership in related technical societies, participation in oral or written technical discussion, or visits to related engineering projects?" With 64 reporting encouragement and 35 others reporting subsidization, more than 90 per cent of those replying to the question acknowledge a definite employer interest in attendance at engineering meetings. The small encouragement reported for membership in engineering societies suggests the possibility that membership was intended to be included with attendance. Encouragement for visiting other engineering projects seems to be confined to the construction, public works, and structures groups.

Finally, each alumnus was requested to discuss "how you think a young civil engineering graduate could adapt, develop, and broaden himself for advancement in the profession during the first five years after graduation." The replies varied greatly, but the composite answer might be worded thus: "Make an intelligent program for study and reading; endeavor to improve personal traits; affiliate with engineering societies and engineers; improve your situation through study of engineering practice; take part in community service; keep in touch with alma mater; cultivate and use common sense."

The data for this article have been supplied through the courtesy of A. H. Fuller, M. Am. Soc. C.E.

NEWS OF ENGINEERS

Personal Items About Society Members

E. COURTLANDT EATON, consulting engineer of Los Angeles, Calif., has just spent four months in Palestine in an advisory capacity on water-development matters for the Palestine Water Company, Ltd.

MORRIS LIEBESKIND has, with Ralph Cosenza, established a consulting engineering practice in New York City, where he will specialize in the design and inspection of structures. Mr. Liebeskind was formerly connected with the Thompson-Starrett Company of the same city.

ABEL WOLMAN recently resigned as public works administrator for Maryland and Delaware to accept an appointment as professor of sanitary engineering at Johns Hopkins University.

ROSS WHITE has resigned as general construction superintendent for the Tennessee Valley Authority to become general manager for Brown and Root, Inc., and the McKenzie Construction Company, contractors for the Marshall Ford Dam on the Colorado River, near Austin, Tex.

JOHN H. LEWIS, consulting engineer of Portland, Ore., has been appointed engineer for the newly established Cascade Locks Port District, in Hood River County, Oregon.

EDWARD L. WINSLOW, formerly assistant engineer in the Corps of Engineers, U. S. Army, at Zanesville, Ohio, is now engaged in flood-control work for the Pennsylvania department of flood control and forestation.

ZINA E. SEVISON has resigned as city engineer of Cheyenne, Wyo., to become state highway engineer of North Dakota.

ELMER C. BARTON is now city engineer of Bluefield, W.Va. He was previously city engineer of Princeton, W.Va.

JOHN C. REMINGTON, JR., and WILLIAM A. GOFF have dissolved the firm of Remington and Goff at Camden, N.J. With other engineers, Mr. Remington has formed the consulting firm of Perring and Remington Company, with offices in Baltimore, Md., and Camden. Mr. Goff has opened an office in Philadelphia for the practice of private and general municipal engineering.

FRED E. RIGHTOR, president and treasurer of the Southwest Bitulithic Company, of San Antonio, Tex., has been appointed a member of the Texas State Board of Engineer Examiners for a six-year term.

CASPER D. MEALS, formerly wire rope engineer for the B. Greening Wire Company Ltd., of Hamilton, Canada, is now chief engineer in the wire rope division of the Bethlehem Steel Corporation at Williamsport, Pa.

CYRIL S. ADAMS has taken a year's leave of absence from the Agricultural and Mechanical College of Texas, where he is assistant professor of civil engineering, and is now employed in the engineering office of the Lower Colorado River Authority at Austin, Tex.

C. R. YOUNG, professor of civil engineering at the University of Toronto, has been appointed a member of the Royal Commission on Transportation recently set up by the Ontario government to investigate and report on all matters pertaining to the transportation of freight and passengers.

ERNEST P. GOODRICH, consulting engineer of New York City, writes of war conditions in China, where he is acting as chief engineer for the Chinese Central Government in the reconstruction of the Canton harbor. He says that at night Canton is frequently darkened because of air raids and he comments on the probability of a complete traffic tie-up on river and railroad as a result of the war. "In the meantime," says Mr. Goodrich, "we are safe enough living in the British concession."

ERIC FLEMING, until recently engineer and chief of the progress and cost section of the U. S. National Park Service, Washington, D.C., has accepted a position as designing engineer for the Ambursen Dam Company, of New York City.

JOHN LOWE III has been appointed instructor in civil engineering at the University of Maryland.

CHARLES H. TORREYSON recently resigned as assistant engineer in the U. S. Bureau of Agricultural Engineering at New Madrid, Mo., to become associate civil engineer in the project planning division of the Tennessee Valley Authority at Knoxville, Tenn.

H. BIRCHARD TAYLOR has accepted appointment as executive director of the University of Pennsylvania's fund-raising drive, which opened October 18.

LELAND K. HILL, who is in the Corps of Engineers, U. S. Army, was recently transferred from the U. S. Engineer Office in the First District, New York City, to the Appalachian Forest Experiment Station of the U. S. Forest Service as an associate engineer on watershed studies and flood-control surveys. His headquarters are in Asheville, N.C.

J. A. RIVIERE has been promoted from the position of project engineer for the Florida State Road Department to that of division engineer for the same organization.

PAUL ANDERSEN is now assistant professor of structural engineering at the University of Minnesota.

PAUL L. BROCKWAY, city engineer of Wichita, Kans., has been appointed a member of the Kansas Registration Board for Professional Engineers.

A. HARRY WAGNER, previously instructor in civil engineering at the Drexel Institute of Technology, is now field engineer for the Portland Cement Association, with headquarters in Philadelphia, Pa.

F. C. WHITNEY is now senior engineer for J. I. Byrne, consulting engineer of Detroit, Mich. He was formerly structural engineer for the Missouri Light and Power Company, St. Louis, Mo.

ROBERT H. RUPKEY, until recently assistant engineer in the U. S. Indian Irrigation Service at Albuquerque, N.Mex., has accepted a position as engineer for the United Pueblos Agency, in the same city.

HAROLD S. FARNEY, junior hydraulic engineer in the Corps of Engineers, U. S. Army, has been transferred from Boston, Mass., to the Little Rock, Ark., district office.

DANIEL SOLINS, formerly junior engineering draftsman in the industrial department of the U. S. Navy Yard, has become senior topographic draftsman in the U. S. Engineer Office at Binghamton, N.Y.

MILO S. KETCHUM, JR., was recently appointed assistant professor of structural engineering at the Case School of Applied Science. He was previously in the Structural and Technical Bureau of the Portland Cement Association, Chicago, Ill.

WILLIAM T. CORUM, formerly in charge of the Glendale (Calif.) transportation office of the U. S. Forest Service, has been transferred to the San Francisco office as assistant engineer on minor roads.

JOHN G. SUTHERLAND has been promoted from the position of transitman in the division engineer's office of the Canadian Pacific Railway to that of assistant engineer in the office of engineer, maintenance of way, eastern lines, of the same railway. His headquarters are now in Toronto.

C. O. DOHRENWEND has taken over his duties as instructor of civil engineering at the Armour Institute of Technology, where he will continue his research in the field of applied elasticity. Mr. Dohrenwend was previously an instructor in the civil engineering department at the Rensselaer Polytechnic Institute.

WENDELL C. WYATT is now assistant engineer in the Kansas State Board of Health, with headquarters at Lawrence, Kans. He was formerly with Black and Veatch in Kansas City, Mo.

DECEASED

ALBERT WORTHINGTON ATWATER (Assoc. M. '19) progress engineer for the Tennessee Valley Authority, at Chattanooga, Tenn., died in New York City on September 24, 1937, from injuries received when he was struck by an automobile. Mr. Atwater, who was 56, was born in Brooklyn, N.Y., and educated at Purdue University. From 1909 to 1912 he was an instructor in trade drawing and mathematics in a Cleveland (Ohio) high school, and from 1912 to 1920 was mechanical engineer for the Cleveland Electric Illuminating Company. Later he was an engineer for Arthur G. McKee and Company, of Cleveland, and for several years before his death was employed by the Tennessee Valley Authority as progress engineer on the construction of Chickamauga Dam.

CYRUS CATES BABB (M. '04) consulting hydraulic engineer of Granite Falls, N.C., died there on October 2, 1937, at the age of 70. Mr. Babb was born in Portland, Me., and graduated from the Massachusetts Institute of Technology in 1890. From 1895 to 1901 he was a hydrographer for the U. S. Geological Survey; from 1901 to 1909, project engineer for the U. S. Bureau of Reclamation; and from 1909 to 1914, chief engineer for the Maine State Water Storage Commission. In 1915 Mr. Babb established a general engineering practice, which he maintained until 1928. He was senior hydraulic engineer in the Corps of Engineers, U. S. Army, from the latter year until 1935, when he resumed his consulting practice.

CLARKE PELEG COLLINS (M. '16) consulting engineer of Clarksburg, W.Va., died at his home there on September 19, 1937. Mr. Collins was born at Narragansett, R.I., and educated in Providence (R.I.) schools and at Rensselaer Polytechnic Institute. His early career included experience as assistant engineer for the Cambria Iron Company, chief engineer for the Somerset Coal Company, and special engineer for the Berwind-White Coal Mining Company. From 1914 to 1918 he was sanitary engineer of Johnstown, Pa.; from 1918 to 1920, senior engineer in the housing department of the U. S. Shipping Board, Emergency Fleet Corporation; and from 1920 to 1925, consulting engineer and manager of the Clarksburg Engineering Company, Inc. In the latter year he established his private practice in Clarksburg.

ELBRIDGE ROBBINS CONANT (M. '17) consulting engineer of Belmont, Mass., died on September 24, 1937, at the age of 72. Mr. Conant was born at Acton, Mass., and educated at Massachusetts Institute of Technology. From 1892 to 1913 he was in the U. S. Engineer Department, with headquarters at Savannah, Ga., and from 1913 to 1919 he was chief engineer and purchasing officer for Savannah, in immediate charge of all public improvements. Later he was town manager of Mansfield, Mass., and city engineer of Manchester, N.H., and he maintained a consulting practice in Brookline, Mass., for a number of years before removing to Belmont.

JOHN ANTHONY CROOK (Assoc. M. '08) proprietor of the Monarch Engineering Company of Falls City, Nebr., and president of the Denver (Colo.) Steel and Iron Works Company, died in Omaha, Nebr., on August 9, 1937. Mr. Crook was born at Falls City on April 9, 1879, and educated at the University of Nebraska. From 1908 to 1926, he maintained a consulting practice, and during part of this period he was also city engineer of Falls City and county engineer of Richardson County, Nebraska. In 1916 Mr. Crook became owner of the Denver Steel and Iron Works Company and the Monarch Engineering Company.

ALBERTUS EUGENE LARROWE (Jun. '33) manager of the Oregon Artists Bureau, Portland, Ore., died on January 6, 1937. Mr. Larrowe was born in Portland and graduated from Oregon State College in 1933. In 1933 and 1934 he was in the Water Resources Branch of the U. S. Geological Survey, and from 1934 to 1935 he was connected with the Bureau of Internal Revenue. Later he was secretary-treasurer of National Attractions, Inc.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

SVEN ALBERT NORLING (Assoc. M. '27) consulting hydraulic engineer of Minneapolis, Minn., died in that city on February 4, 1937. Mr. Norling was born in Soderham, Sweden, on March 21, 1894, and educated at Upsala, Sweden, and the University of Wisconsin. He taught in Sweden in 1919 and 1920 and was resident assistant at the University of Wisconsin from 1921 to 1923. In 1924 Mr. Norling established his consulting practice, and from 1934 until his death he was consulting hydraulic engineer for the CWA, SERA, PWA, and SRA, for the state of Minnesota.

CHARLES ARTHUR POOLE (M. '21) Director of the Society, died suddenly at Niagara Falls, N.Y., on October 14, 1937. Mr. Poole was born in Rochester, N. Y., on June 23, 1874, and graduated from Princeton University in 1895. From 1895 to 1899 he was in the office of the State Engineer and Surveyor of New York; from 1899 to 1904, in railroad work in this country and Norway; from 1904 to 1909, in the New York State Department of Engineering; and from 1910 to 1911 he was engineer for the Ferguson Contracting Company, of New York City. In the latter year he returned to his native city and began a period of service with the city of Rochester that lasted continuously for nearly 23 years—in 1918 he became city

C. ARTHUR POOLE

engineer, in 1928 consulting engineer to the city, and in 1932 city manager. From 1934 on he was resident engineer-inspector for the PWA. During the war Mr. Poole served as a captain in the Corps of Engineers, U. S. Army, being assigned to the 150th Engineers. He was active in the affairs of the Society and had served as president of the Rochester Section. A more detailed account of Mr. Poole's life appears in the "Society Affairs" department of this issue.

ARTHUR CARLING TONER (M. '22) who was in the Chicago office of the Portland Cement Association, died on September 4, 1937. Mr. Toner, who was born in Baltimore, Md., on November 21, 1881, graduated from the University of Pennsylvania in 1904. From 1906 to 1914 he was, successively, assistant engineer and resident engineer in charge of construction for the Sewerage Commission of the City of Baltimore. In the latter year he became connected with the Association of American Portland Cement Manufacturers (now the Portland Cement Association) where he remained the rest of his life, with the exception of a year spent as assistant general manager of the Liberty Shipbuilding Company, contractors for the Emergency Fleet Corporation. During this long period with the Portland Cement Association Mr. Toner served as district manager in Pittsburgh, Washington, and Chicago.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From September 10 to October 9, 1937, Inclusive

ADDITIONS TO MEMBERSHIP

ADAMS, JAMES EDWIN (Jun. '37), With Crane Co., 3652 Ellis Ave., Chicago, Ill.

ALLEN, WILLIAM B. (M. '37), Project Design Engr., TVA (Res., 162 Hillsboro Heights), Knoxville, Tenn.

ANDERSON, IVAR (Assoc. M. '37), 467 Eighty-first St., Brooklyn, N.Y.

AVERY, ELWOOD CHOATE (Assoc. M. '37), Care, Central Illinois Public Service Co., Room 1320, Illinois Bldg., Springfield, Ill.

BLACKER, CARROLL LYNNE (Assoc. M. '37), Chf. Building Insp., City of Palo Alto (Res., 241 Seale Ave.), Palo Alto, Calif.

BOSWELL, LEO DELBERT (Jun. '37), Draftsman, Am. Steel Derrick Co. (Res., 1321 South Atlanta), Tulsa, Okla.

BREUER, WALTER FRANKLIN (Jun. '37), Bureau of Bridges, State Highway Dept., Jefferson City, Mo.

CALDWELL, EUROPE ALEXANDER (Assoc. M. '37), Gen. Supt., Louisiana Materials Co. Inc., 1510 Julia St., New Orleans, La.

CALLAND, ROBERT STEWART (Assoc. M. '37), Care, U. S. Bureau of Reclamation, 2d Floor, Old Post Office Bldg., Sacramento, Calif.

COFF, CHARLES MOSES (Assoc. M. '37), Mgr., with J. A. Tertelings & Sons, Haas Doughty & Jones and Morrison Knudsen Co. for Tri-county Project, 909 South 36th St., Lincoln, Nebr.

CONNOR, THOMAS ROWLEY (Assoc. M. '37), Senior Asst. Engr., Dept. of Public Utilities, Div. of Water (Res., 14625 Caldwell Ave.), Cleveland, Ohio.

CREW ALFRED, III (Jun. '37), Asst. to Res. Engr., Morris Knowles, Inc. (Res., 301 Russell St.), Bluefield, W.Va.

DAIGLE, JOSEPH EDGAR (Jun. '37), 546 South Bright St., Whittier, Calif.

DANEL, PIERRE FRANCOIS (Assoc. M. '37), Research Engr., Neyret-Beylier Piccard-Pictet; Director of Hydr. Laboratory, Ecole des Ingenieurs Hydrauliciens, Grenoble Univ., 10, Rue de Belgrade, Grenoble, France.

DARDEN, WILLIAM ALLEN, JR. (Jun. '37), Surveyman, U. S. Engr. Office, Nashville, Tenn.

DAVIS, BERTON EMERSON (Jun. '37), Clerk, Pennsylvania Liquor Control Board, 829 Electric St., Scranton, Pa.

DILLON, GLEN EARL (Jun. '37), 135 Miramar Ave., San Rafael, Calif.

DILLON, WILLIAM SHERIDEN, JR. (Jun. '37), Box 787, Longview, Tex.

DRUSCHEL, RUSSELL HENRY (Assoc M. '37), Surveyman, U. S. Engr. Office (Res., 5737 Holden St.), Pittsburgh, Pa.

ERIM, SUAD KADRI (Jun. '37), No. 261, Bagdad Caddesi, Pendik, Istanbul, Turkey.

FAY, ALFRED LESTER (Assoc. M. '37), With New England Power Assoc., 441 Stuart St., Boston (Res., 92 Pond St., Natick), Mass.

FIORE, MICHAEL EDWARD (Jun. '37), 1108 South 1st St., Champaign, Ill.

GARLOCK, SPRAGUE GIRVAN (Jun. '37), Junior Engr., New York State Transit Comm., 270 Madison Ave., New York (Res., 25 Parkview Ave., Bronxville), N.Y.

GEISSER, GEORGE JOHN (Assoc. M. '37), Chf. Engr., Public Buildings Dept., City Hall, Providence, R.I.

GIGSTAD, KNUT (Assoc. M. '37), Senior Engr., WPA, Parks Dept., New York City (Res., 350 Fort Washington Ave.), New York, N.Y.

GOLDSTEIN, NATHAN (Jun. '37), 2036 Seventy-fourth St., Brooklyn, N.Y.

GOSSELIN, URBAN DAMAS (Assoc. M. '37), Job Engr., F. H. McGraw & Co., 51 East 42nd St., New York, N.Y.

GREEN, EARL (Assoc. M. '37), Junior Highway Engr., U. S. Bureau of Public Roads, 604, Plaza Bldg., Sacramento, Calif.

GRUY, ANDREW MELROSE (Jun. '37), Care, Humble Oil & Refining Co., Midland, Tex.

HADDOCK, FREDERICK RAYMOND (M. '37), Chf. Engr., Roberts Filter Mfg. Co., Darby (Res., 1342 South Wilton St., Philadelphia), Pa.

HAGEMEYER, WALTER GEORGE (Assoc. M. '37), Asst. Highway Engr., State Div. of Highways, Bureau of Maintenance (Res., 461 West Cook St.), Springfield, Ill.

HAGER, MILTON BLANCHARD (Assoc. M. '37), Asst. Civ. Engr., War Dept., Engr. Dept., U. S. Engrs. Office, Park Sq. Bldg., Boston, Mass.

HANSON, ARCHIE JAMES (Jun. '37), Junior Hydr.

Engr., U. S. Geological Survey, Box 1311, Tucson, Ariz.

HUBBELL, GEORGE EDGAR (Assoc. M. '37), Instr., Civ. Eng., Wayne Univ., Detroit, Mich.

IRWIN, JOHN PAULETTE (Jun. '37), King City, Mo.

ITSCHNER, EMERSON CHARLES (Assoc. M. '37), Capt., Corps of Engrs., U.S.A., Box 93, Louisiana, Mo.

LAWRENCE, JOHN HEYER (Assoc. M. '37), Mech. Engr. for Engr. of Plant Div., Western Elec. Co., Inc. (Res., 6314 Frederick Ave., Catonsville), Baltimore, Md.

ILLEVANG, OMAR JOHANSEN (Jun. '37), Draftsman, Coachella Val. County Water Dist., Coachella, Calif.

LYONS, DAN JOSEPH (Assoc. M. '37), Res. Engr., State Highway Dept., Route 2, Box 660, Tucson, Ariz.

MACDONALD, RALPH CONNER (Jun. '37), 2912 Deakin St., Berkeley, Calif.

MCNALLY, CHRISTOPHER JOSEPH (Assoc. M. '37), Chf. Engr., Cement Gun Co. (Res., 217 North 19th St.), Allentown, Pa.

MATEJKA, FRANKLIN KOUKOL (Assoc. M. '37), Asst. Engr., U. S. Bureau of Reclamation, Denver, Colo.

MILLER, JACOB JOHN (Jun. '37), Junior Engr., U. S. Engrs., 1 Underwood Lane, Pittston, Pa.

MILLS, ALAN G. (Assoc. M. '37), Architectural Engr., Southwestern Bell Telephone Co., 1101 Telephone Bldg., Oklahoma City, Okla.

MOSHER, ARTHUR AUGUSTIN (Jun. '37), With the R. Hardesty Mfg. Co., Box 492, Pueblo, Colo.

MRUZ, JOHN MATHEW (Jun. '37), Project Clerk for M. Ross Watson, 701 South Adams, Tallahassee, Fla.

NOBLE, JOHN LOCKE (Jun. '37), Laboratory of Mechanics, Dept. of Theoretical and Applied Mechanics, Iowa State Coll., Ames, Iowa.

PADDOCK, LEON ALFRED (M. '37), Pres., Virginia Bridge Co.; Pres., Am. Bridge Co. (Res., 2087 Beechwood Boulevard), Pittsburgh, Pa.

PARDO STOLK, EDGAR (Assoc. M. '37), Technical Director, Ministry of Public Works, Apartado Correos 614, Caracas, Venezuela.

PILLEY, EDWARD FEARN (Assoc. M. '37), Res. Engr., State Highway Dept., Box 386, Levelland, Tex.

PRATT, LAWRENCE FULLER (Assoc. M. '37), Eng. Draftsman, TVA (Res., 1156 Luttrell St.), Knoxville, Tenn.

PUFFER, LOUIS BLACKMER (M. '37), Prof., Civ. Eng., Univ. of Vermont, Coll. of Eng. (Res., 176 Loomis St.), Burlington, Vt.

RANSON, JOHN GRAY (Assoc. M. '37), Computer, U. S. Geological Survey, Martinsville, Ill.

REARDON, LESLIE JOSEPH (Assoc. M. '37), Res. Engr., Insp., PWA, Cincinnati (Res., 11811 Moulton Ave., Cleveland), Ohio.

RICHARDS, GORDON VAUGHN (Jun. '37), International House, Berkeley, Calif.

ROBERTSON, UNION BANNER (Assoc. M. '37), Bridge Engr., U. S. Dept. of Agriculture, Bureau of Public Roads (Res., 406 Grant St.), Santa Fé, N.Mex.

SAWYER, ROBERT KENNETH (Jun. '37), 709 East Ivinson, Laramie, Wyo.

SMITH, FREDERICK CHARNLEY (Assoc. M. '37), Asst. Prof., Civ. Eng., Univ. of Washington (Res., 5717 Thirty-third Ave., N.E.), Seattle, Wash.

SMITH, WALTER PRESTON (Jun. '37), 38 Mallorca Way, San Francisco, Calif.

TERHUNE, VICTOR WILLETT (Jun. '37), Project Engr., State Highway Comm., 708 First St., La Porte, Ind.

THOMSON, CARL WHEATLEY (Jun. '37), Care, State Division of Highways, Bishop (Res., 2413 U St., Sacramento), Calif.

TRAVIS, JAMES EDWARD (Assoc. M. '37), Associate Civ. Engr., Suburban Div., FSA, Box 106, Hales Corners, Wis.

VOSTEEN, FRED HENRY (Assoc. M. '37), Asst. Engr., Met. Water Dist. of Southern California, Banning (Res., 453 Euclid Ave., Beaumont), Calif.

WEGMAN, LEONARD SAMUEL (Jun. '37), Senior Engr., Chf. of Reports Section, U. S. WPA for New York City, Dept. of Docks (Res., 511 West 232nd St.), New York, N.Y.

WHITE, ROBERT EMELIN (Jun. '37), Engr., Spencer, White & Prentis, Inc. (Res., 110 Riverside Drive), New York, N.Y.

WOOLVERTON, (MISS) MARGARET GENEVIEVE (Jun. '37), 949 South Hoover St., Los Angeles, Calif.

ZIEGLER, AMOS ADDIS, JR. (Jun. '37), 826 Thorn St., Sewickley, Pa.

MEMBERSHIP TRANSFERS

BURKE, MAXWELL FOLLANSBEE (Jun. '29; Assoc. M. '37), Hydr. Engr., Los Angeles County Flood Control Dist., 205 South Broadway, Los Angeles (Res., 1166 Sherwood Rd., San Marino), Calif.

CANFIELD, GEORGE HOWARD (Assoc. M. '15; M. '37), Dist. Engr., U. S. Geological Survey, Water Resources Branch, 606 Post Office Bldg., Portland, Ore.

CORNELL, GEORGE MILTON (Jun. '27; Assoc. M. '37), Transportation Insp., C. & O. Ry. (Res., 1145 Ninth Ave.), Huntington, W.Va.

DAVISON, GEORGE STEWART (M. '90; Hon. '37), Pres. Davison Coke and Iron Company, 2123 Oliver Bldg., Pittsburgh, Pa.

DEMARTINI, FRANK EDWARD (Jun. '27; Assoc. M. '37), Water Purification Engr., San Francisco Water Dept., Millbrae (Res., 670 Lombard St., Apartment 2, San Francisco), Calif.

DIEHL, RAY PURDY (Jun. '30; Assoc. M. '37), Cons. Engr., 74 Chapel St., Albany, N.Y.

GREEN, ROBERT REEDER (Jun. '27; Assoc. M. '37), Designer, Chemical Constr. Co.; 561 East State St., Trenton, N.J.

HILTON, RALPH LIVINGSTON (Jun. '26; Assoc. M. '37), With Eng. Dept., The Paraffine Companies, Inc., 4500 Santa Fé Ave., Los Angeles (Res., 219 Euclid Ave., Long Beach), Calif.

HOVEY, OTIS ELLIS (Assoc. M. '94; M. '00; Hon. M. '37), Cons. Engr., 71 Broadway, New York, N.Y.

JOHNSTON, BRUCE GILBERT (Jun. '34; Assoc. M. '37), Instr., Civ. Eng., Columbia Univ., 421 Eng. Bldg., Columbia Univ., New York, N.Y.

KILEY, GEORGE THOMAS (Jun. '28; Assoc. M. '37), Supt., P. T. Cox Contr. Co., 154 Nassau St., New York, N.Y. (Res., 92 Woodlawn Ave., Jersey City, N.J.)

TOTAL MEMBERSHIP AS OF OCTOBER 9, 1937

Members	5,614
Associate Members	6,063
Corporate Members	11,677
Honorary Members	26
Juniors	3,406
Affiliates	79
Fellows	1
Total	15,189

LABELLE, WALTER ERNEST (Jun. '30; Assoc. M. '37), Erection Engr., Bethlehem Steel Co., 8301 Stewart Ave. (Res., 11436 South Irving Ave.), Chicago, Ill.

LESLIE, JAMES BOOTH (Jun. '33; Assoc. M. '37), Asst. Engr., U. S. Engr. Office (Res., 727 National St.), Vicksburg, Miss.

LIDICKER, WILLIAM ZANDER (Jun. '28; Assoc. M. '37), Engr. in Chg. of Design, U. S. Engr. Office (Res., 866 Summit Ave.), St. Paul, Minn.

LITEHISER, ROBERT REID (Assoc. M. '29; M. '37), Chf. Engr., Bureau of Tests, State Highway Dept., State Highway Testing Laboratory, Ohio State Univ. Campus (Res., 2712 Tremont Rd.), Columbus, Ohio.

MACALPINE, DAVID MUIR (Jun. '28; Assoc. M. '37), Instr., Coll. of the City of New York, School of Technology, New York, N.Y.

MACDONALD, HOWARD DANIEL (Jun. '29; Assoc. M. '37), Constr. Supt., Western Precipitation Corporation, 1016 West 9th St. (Res., 1325 North Mariposa St.), Los Angeles, Calif.

MEAD, JOHN DAVID (Jun. '27; Assoc. M. '37), Engr., Brooklyn Eastern Dist. Terminal, 86 Kent Ave., Brooklyn (Res., 102 West 85th St., New York), N.Y.

NIBMAN, ARTHUR ROBERT (Jun '30; Assoc. M. '37), Night Supt. and Field Engr., Columbia Constr. Co., Bonneville, Ore.

POLKINGHORNE, WILFRID CARLOS (Assoc. M. '30; M. '37), Associate Prof., Civ. Eng., Michigan Coll. of Min. and Technology (Res., 105 Clark St.), Houghton, Mich.

POULTER, ALFRED FEAREY (Jun. '29; Assoc. M. '37), Mgr., California Water Service Co., Box 218, Menlo Park, Calif.

POWELL, VIRGIL OSCAR (Jun. '29; Assoc. M. '37), Asst. Hydr. Engr., TVA, 501 Union Bldg., Knoxville, Tenn.

ROGERS, GORDON FARRAND (Jun. '30; Assoc. M. '37), Supt., Merritt-Chapman & Scott Corporation (Res., 1101 Dolphin St.), San Pedro, Calif.

SMITH, ROBERT JOHN (Jun. '27; Assoc. M. '37), Res. Engr., State Building Dept., Care, Bureau of Eng., State Dept. of Health, Lansing, Mich.

SMITH, ROBERT TRUMBULL (Jun. '30; Assoc. M. '37), Dist. Mgr., Wallace & Tiernan Co., Inc., 416 Flour Exchange Bldg., Minneapolis, Minn.

TSATSOS, ALEXANDER GEORGE (Jun. '33; Assoc. M. '37), Asst. Gen. Mgr., E R T H A Cy., 17 Canning St., Athens (Res., 37 Tatoi Rd., Kephissia, near Athens), Greece.

VAN KLEECK, LEROY WINFIELD (Jun. '27; Assoc. M. '37), Senior San. Engr., State Dept. of Health, 165 Capitol Ave., Hartford, Conn.

WEDDINGTON, CHARLES FOREMAN (Jun. '32; Assoc. M. '37), Acting Res. Engr., State Highway Dept., Box 1286, Houston, Tex.

WORCESTER, JOSEPH RUGGLES (M. '95; Hon. M. '37), Cons. Engr., 79 Milk St., Boston, Mass.

REINSTATEMENTS

BARBER, IVAN WILMOT, Assoc. M., reinstated Sept. 22, 1937.

SHERMAN, MYRON WOOD, Assoc. M., reinstated Sept. 20, 1937.

WISE, JOSEPH ALEXANDER, M., reinstated Sept. 13, 1937.

RESIGNATIONS

CHASE, EDWARD, Jun., resigned Oct. 4, 1937.

JORY, JOHN GODFREY, Jun., resigned Sept. 9, 1937.

KIRKMAN, HERBERT MARKEY, Assoc. M., resigned Oct. 1, 1937.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

November 1, 1937 NUMBER 11

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years †	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

ADLER, LOUIS, Astoria, N.Y. (Age 28.) Refers to R. E. Goodwin, W. L. Willig.

ANDERSON, ROSCOE WILLIAM, Scottsboro, Ala. (Age 37.) Field Unit Chf., TVA Maps & Surveys Div., Chattanooga, Tenn. Refers to J. C. Bisset, B. B. Brier, H. W. English, A. S. Fry, L. L. Hidinger, N. H. Sayford, F. W. Truss, G. D. Whitmore.

ASHWORTH, IRVING FRANCIS, New York City. (Age 38.) Asst. Engr., Grade 4, Office of Chf. Engr., Board of Estimate and Apportionment. Refers to C. K. Conard, F. T. Lawton, J. C. Riedel, W. F. Rugg, C. Seaver, W. J. Shea, S. I. Sherman.

BOTSFORD, JOHN ROBERT, San Benito, Texas. (Age 33.) Senior Draftsman, Dept. of State. Refers to J. L. Lytel, W. C. McNown, A. J. Moore, F. A. Russell, N. T. Veatch, Jr.

BRUCKNER, CHARLES JOHN, Philadelphia, Pa. (Age 27.) Refers to H. L. Bowman, R. V. Giles, S. J. Leonard.

BURD, GEORGE ADAMS, Jamaica, N.Y. (Age 25.) Refers to R. W. Abbett, W. C. Taylor.

CLARK, JOE CALHOUN, Marshall, Tex. (Age 37.) Acting Res. Engr., Texas State Highway Dept. Refers to C. C. Cagle, W. D. Dockery, G. H. Gilchrist, B. P. Greenwade, D. C. Greer, A. D. Hutchison, W. A. Ortolani, A. D. Schmid.

CRANFORD, ELMO LEAVINES, Coulee Dam, Wash. (Age 35.) Party Chf., Grade 11, U. S. Bureau of Reclamation. Refers to H. S. Hurlburt, W. E. Jessup, D. R. McFarland, D. O. Nelson, E. J. Niemen, M. J. Whitson.

DAVIS, DANIEL TRIGG MCCABE, Childress, Tex. (Age 37.) County Engr., Childress County. Refers to S. D. Bacon, K. C. Cade, H. P. Kay, E. W. Mars, J. E. Ward.

DEGROVE, RUSSELL HENRY, Jacksonville, Fla. (Age 30.) Asst. Civ. Engr. with Robert M. Angas. Refers to R. M. Angas, A. Brest, W. W. Fineren, T. M. Lowe, A. F. Perry, Jr.

DUNHAM, FRANK CROMIE, Chattanooga, Tenn. (Age 23.) Jun. Eng. Aide, TVA. Refers to R. P. Black, C. D. Gibson, T. P. Pendleton, F. C. Snow.

EUSTIS, ERNEST LEWIS, JR., Maracaibo, Venezuela. (Age 26.) Surveyor, Caribbean Petroleum Co. Refers to E. S. Bres, S. J. Buchanan, D. Derickson, R. R. Runck, H. A. Sargent, H. D. Vogel, C. P. Wright.

EVERHAM, ARTHUR THOMPSON, Los Angeles, Calif. (Age 28.) Engr., Raymond Concrete Pile Co. Refers to A. C. Everham, C. S. Foreman, A. D. Harvey, O. S. Struthers, H. P. Treadway, O. A. Zimmerman.

FETTER, ROY EUGENE, Sacramento, Calif. (Age 36.) Asst. Bridge Engr., Bridge Dept., Div. of Highways, State of California. Refers to J. H. Diehl, F. A. Kittredge, F. W. Panhorst, R. Wagner, D. R. Warren, P. R. Watson.

FICARRATTO, SADO CARL, Davenport, Iowa. (Age 28.) Jun. Engr., U. S. Engrs., Rock Island Dist. Refers to J. F. Mangold, R. L. Stevens.

FORERO BENAVIDES, MANUEL GUILLERMO, Bogota, Colombia. (Age 31.) Engr., Compania de Ingenieros Constructores. Refers to J. B. Babcock, 3d, C. B. Breed, E. Mirabelli, H. Sutherland, P. Uribe Gauguin.

FRETTS, WALLACE VAN RENSSELAER, Williamsville, N.Y. (Age 37.) Member of firm, Fretts, Tallamy & Senior, Cons. Engrs. Refers to G. D. Diehl, C. H. Field, G. T. Horton, S. W. Jackson, S. S. Neff, C. A. Poole, F. H. Robinson, C. H. F. Snyder, B. D. Tallamy, W. C. Taylor, F. K. Wing.

FRIEDBERG, ISAIAH, New York City. (Age 21.) Refers to R. C. Brumfield, F. E. Foss, J. P. J. Williams.

GARNETT, RAYMOND RAITHEL, Providence, R.I. (Age 29.) Jun. Engr., U. S. Engr. Office. Refers to C. E. Boesch, F. E. Fahlquist, H. Rubey, W. R. Vawter, H. A. Whitcomb.

GILSON, W IRVING, Brownsville, Tex. (Age 49.) Mgr. of Dist., Cameron County Water Control Dist. No. 6. Refers to C. S. Clark, V. L. Conrad, E. B. Darby, E. B. Gore, H. H. Kidder, A. Tamm, W. O. Washington, B. F. Williams.

GINSBURG, ABRAM, New York City. (Age 37.) Tunnel Designer, New York City Tunnel Authority. Refers to D. G. Baillie, Jr., A. Brahdy, J. C. Evans, J. Mechanic, J. J. Nanry, J. H. Quimby, O. Singstad.

GOULD, EDWARD PULASKI, Tulsa, Okla. (Age 23.) Draftsman, Patterson Steel Co. Refers to J. B. Butler, E. W. Carlton.

HARTMAN, OTTO CHARLES, Bonneville, Ore. (Age 51.) Engr., U. S. Engrs. Refers to R. R. Clark, J. P. Growdon, J. P. Hart, R. F. Hoffmark, B. M. Howard, B. Morrow, B. E. Torpen.

HIRSCHMAN, PAUL, New York City. (Age 24.) Draftsman, Gibbs & Hill, Cons. Engrs. Refers to R. C. Brumfield, F. E. Foss, L. W. Joseph.

HUDSON, RICHARD CLAYTON, West Boylston, Mass. (Age 23.) Asst. to Supt., E. J. Cross Co., Worcester, Mass. Refers to H. P. Burden, F. N. Weaver.

IRVIN, LESLIE ARTHUR, Los Angeles, Calif. (Age 25.) Structural Engr. with T. C. Kistner, Archt. Refers to C. Derleth, Jr., C. G. Hyde, L. K. Osborn, W. T. Wright.

IRVING, WALTER EDWARD, Glenbrook, Conn. (Age 64.) Pres., Irving Iron Works Co., and Irving Subway Grating Co., Inc. Refers to G. S. Davison, O. E. Hovey, T. R. Lawson, G. H. Pegram, H. O. Schermerhorn, R. S. Schermerhorn, Jr., F. E. Schmitt, J. A. L. Waddell.

JOHNSON, WALTER FELIX, New York City. (Age 22.) Asst. Engr., National Bureau of Casualty & Surety Underwriters, Inc. Refers to W. Allan, R. E. Goodwin.

JONES, ROGER EDWARD, Tulsa, Okla. (Age 23.) Constr. Engr., Tulsa Board of Education. Refers to J. E. Kirkham, E. R. Stapley.

KEBNER, KENNETH BIXBY, Denver, Colo. (Age 49.) Senior Engr., U. S. Bureau of Reclamation. Refers to J. B. Bond, J. L. Burkholder, D. W. Cole, J. L. Savage, R. F. Walter.

KIEDAISCH, W. CALVIN, Crescent City, Calif. (Age 31.) Res. Engr., Bridge Dept., Div. of Highways, State of California. Refers to F. S. Foote, J. Gallagher, I. O. Jahlstrom, S. B. Lane, F. W. Panhorst, R. H. Twaddle.

KLOTZBACH, WILLIS O'BRIEN, Milltown, N.J. (Age 22.) Draftsman, Lehigh Valley R.R., Bethlehem, Pa. Refers to W. S. Lohr, L. Perry, P. P. Rice, H. T. Rights, E. H. Rockwell, F. C. Stehle, H. A. Wistrich.

LEFEVER, FLOYD FRANK, Santa Fe, N.Mex. (Age 32.) Asst. Engr., U. S. Geological Survey, Washington, D.C. Refers to R. Follansbee, N. C. Grover, B. Johnson, R. I. Meeker, C. E. Mickey, C. G. Paulsen.

LEONARD, RAYMOND WESLEY, Asheville, N.C. (Age 27.) Jun. Engr., Water Resources Branch, U. S. Geological Survey. Refers to E. D. Burchard, W. G. Geile, C. M. Lambe, J. L. Lamson, C. L. Mann, W. C. Riddick, H. Tucker.

LINK, HOWARD CHARLES, Southington, Conn. (Age 23.) Refers to E. W. Bowler, R. R. Skelton.

LOEBACH, FERDINAND ALOIS, La Salle, Ill. (Age 26.) Refers to N. D. Morgan, C. E. Palmer.

LOONEY, CHARLES THOMAS GEORGE, Iowa City, Iowa. (Age 31.) Asst. Prof. of Civ. Eng., State Univ. of Iowa. Refers to H. Cross, T. F. Hickerson, W. C. Huntington, T. D. Mylrea, W. M. Wilson.

MCLEAN, ANDREW ALEXANDER, Ballan, Victoria, Australia. (Age 32.) Shire Engr. and Secy. Refers to H. H. Bell, R. R. B. Bennett, L. T. Guy, W. M. Pullar, C. W. N. Sexton.

MANGASARIAN, RICHARD DICRAN, New York City. (Age 24.) Refers to W. Allan, R. E. Goodwin.

MANN, JOHN HERBERT CLAIBORNE, Lexington, Va. (Age 37.) Asst. Prof. of Civ. Eng., Virginia Military Inst. Refers to J. A. Anderson, H. K. Barrows, C. B. Breed, E. M. Hastings, H. G. Shirley, S. B. Williamson, H. A. Yancey.

MARR, ROBERT ATHELSTAN, JR., Lexington, Va. (Age 41.) Prof., Dept. of Civ. Eng., Virginia Military Inst. Refers to J. A. Anderson, E. M. Hastings, H. G. Shirley, H. Sutherland, W. D. Tyler.

MENDEZ, RAFAEL MARTIN, JR., Santurce, Puerto Rico. (Age 24.) Refers to C. D. Gibson, F. C. Snow, E. Totti y Torres, C. del Valle Zeno.

MOYSE, JACK, Indianapolis, Ind. (Age 31.) With State Highway Comm. of Indiana. Refers to C. A. Ellis, W. K. Hatt, W. J. Henderson, L. E. Martin, B. E. Phelps.

O'DONNELL, HERBERT PRESTON, Bishop, Calif. (Age 29.) Jun. Highway Engr., California Div. of Highways. Refers to H. Barnes, M. W. Ellis, T. E. Stanton, Jr.

PETTY, BENJAMIN HARRISON, West Lafayette, Ind. (Age 49.) Prof. of Highway Eng., Purdue Univ. Refers to O. N. Floyd, I. E. Houk, M. R. Keefe, G. E. Martin, R. L. Morrison, J. W. Wheeler, R. B. Wiley.

PROTZE, HERMAN GUSTAV, JR., Roslindale, Mass. (Age 26.) Engr., The Thompson & Lichtner Co., Inc. Refers to M. N. Clair, J. J. Hurley, D. Peabody, Jr., M. Solomon, S. E. Thompson.

PURDOM, PAUL WALTON, Atlanta, Ga. (Age 20.) Asst. Engr., Georgia Power Co. Refers to R. P. Black, C. D. Gibson, F. C. Snow.

QUINN, RUSSELL CHESTER, Romney, W.Va. (Age 36.) Area Engr., WPA, Elkins, W. Va. Refers to J. P. Blundon, M. Cilley, J. B. Hoke, B. D. Johnson, F. J. Pfeifer, M. W. Smith, Jr., C. Swecker.

REYNOLDS, EMBREE ENSIGN, Oakland, Calif. (Age 28.) Jun. Bridge Constr. Engr., State of California, San Francisco-Oakland Bay Bridge, San Francisco, Calif. Refers to H. A. Blau, A. H. Brownfield, N. R. Gindrat, I. O. Jahlstrom, L. J. Jennings, I. L. Johnson, R. R. Rowe, L. K. Wood.

RICHHEIMER, CHARLES EDWARD, Jacksonville, Fla. (Age 29.) Vice-Pres., G. A. Youngberg and Associates, Inc., Cons. Engrs. Refers to E. W. Bowler, G. B. Hills, T. M. Lowe, R. E. Spaulding, G. A. Youngberg.

ROOD, JOSEPH EDWARD, New York City. (Age 20.) Draftsman, Gibbs & Hill, Inc. Refers to W. Allan, T. H. Prentice.

RUTLEDGE, PHILIP CASTEEN, Lafayette, Ind. (Age 31.) Associate Prof. of Civ. Eng., Purdue Univ. Refers to A. Casagrande, J. S. Crandall, G. M. Fair, G. Gilboy, H. A. Mohr, C. Terzaghi, H. M. Westergaard.

SCHILLER, BERNARD, El Centro, Calif. (Age 22.) Deputy Health Officer, Imperial County Health Dept. Refers to C. G. Gillespie, C. G. Hyde, B. Jameyson, G. E. Troxell, C. T. Wiskocil.

SCHLUBACH, HENRY LESLIE, Mason City, Wash. (Age 32.) Field Engr., Cofferdam Dept., Mason-Walsh-Atkinson-Kier Co., Contrs., Coulee Dam. Refers to K. V. Jones, D. R. McFarland, D. O. Nelson, E. J. Niemen, C. D. Riddle, S. H. Woodard.

SCHULHAUSER, EDWARD VICTOR, McMinnville, Ore. (Age 38.) Associate Engr., Farm Security Administration, U. S. Dept. of Agriculture. Refers to O. R. Bosso, L. E. Brigham, C. M. Everts, Jr., H. W. King, R. L. Morrison, C. O. Wisler.

SPARKS, ROBERT EARL, Troup, Tex. (Age 24.) Engr., Sinclair Refining Co., Pipe Line Dept., Ft. Worth, Tex. Refers to O. V. Adams, L. C. Ingram, Jr., W. L. Kuehnle, J. H. Murdough.

STIRNI, ALBERT RICHARD, Washington, D.C. (Age 27.) Geodetic Computer, U. S. Coast & Geodetic Survey. Refers to H. C. Avers, R. P. Black, W. E. Reynolds, F. C. Snow, J. G. Staack, R. M. Wilson, E. M. Woods.

STOOPS, CHAUNCEY NOTEWARE, Dravosburg, Pa. (Age 25.) Research Engr., Pittsburgh Plate Glass Co. Refers to C. G. Dunnells, F. M. McCullough, C. B. Stanton, H. A. Thomas.

STO. TOMAS, ENRIQUE CORTES, Manila, Philippine Islands. (Age 35.) In private practice. Refers to O. A. Boni, H. W. Corp, M. Cruz, F. Rodriguez y Catarroja, T. A. Saddam, M. V. Zabat.

TRACEY, STEPHEN EDWARD, Willoughby, Ohio. (Age 42.) Structural Engr., The American Steel & Wire Co., Cleveland, Ohio. Refers to F. R. Burnette, R. L. Harding, A. Miller, F. A. Pease, F. L. Plummer, H. C. Plummer, W. J. Watson.

WALKER, JAMES MATT, Ft. Worth, Tex. (Age 29.) Office Engr., Tarrant (Tex.) County, Engrs. Dept. Refers to F. D. Hughes, H. A. Hunter, W. O. Jones, W. L. Kelly, D. L. Lewis, F. E. Lovett.

WALL, CLAUDE HUTCHINSON, Columbus, Ohio. (Age 46.) Associate Prof. of Civ. Eng., Ohio State Univ. Refers to E. F. Coddington, C. T. Morris, J. C. Prior, J. R. Shank, C. E. Sherman, R. C. Sloane.

WATTS, FERRIS THOMAS, Short Hills, N.J. (Age 32.) Supt., Hartshorn Estate. Refers to H. W. Bluhm, H. N. Cummings, J. A. Darling, W. J. Delaney, W. S. LaLonde, Jr.

WILLIAMS, ADRIAN HARRY, Albany, N.Y. (Age 32.) Asst. Engr., U. S. Geological Survey, Water Resources Branch. Refers to R. F. Bessey, G. H. Canfield, C. A. Mockmore, C. G. Paulsen, K. N. Phillips, H. A. Rands.

WILSEY, EDWARD FRANKLIN, Denver, Colo. (Age 36.) Asst. Engr., U. S. Bureau of Reclamation. Refers to D. P. Barnes, M. L. Enger, F. T. Mavis, E. S. Sheiry, W. E. Smith, J. E. Warnock, C. C. Williams.

YOUNG, KENNETH, Omaha, Nebr. (Age 34.) Engr. Examiner with PWA. Refers to J. A. Bruce, W. H. Campen, J. C. Detweiler, G. P. Dorsey, R. E. Edgecomb, J. Latenser, Jr.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

BULLOCK, VIRGIL WILLIAM, Assoc. M., Long Beach, Calif. (Elected Junior Oct. 12, 1925; Assoc. M. June 6, 1927.) (Age 41.) Asst. Engr., U. S. Engr. Dept., Los Angeles. Refers to H. G. Balcom, J. L. Edwards, L. R. Hjorth, C. C. More, H. M. Priest, G. A. Sallans.

ELLABY, CHARLES HAMILTON, Assoc. M., St. Louis, Mo. (Elected Nov. 11, 1929.) (Age 37.) Senior Civ. Engr., U. S. Engr. Dept., Upper Mississippi Valley Div. Refers to C. S. Boardman, A. E. Cummings, E. L. Daley, G. E. Edgerton, H. P. Jones, R. E. Mackenzie, W. H. McAlpine, F. R. McMillan, R. P. Pennoyer, L. F. Reynolds, J. Singleton, F. B. Spencer, L. White, B. R. Wood.

HARDING, JAMES CLARKE, Assoc. M., Mount Kisco, N.Y. (Elected Junior Nov. 21, 1921; Assoc. M. March 5, 1928.) (Age 37.) Cons. Engr. Refers to A. M. Brosius, C. A. Emerson, Jr., C. H. Nichols, J. E. O'Leary, J. F. Sanborn, A. M. Wyman.

HOOPER, OLCOTT LORIN, Assoc. M., Washington, D.C. (Elected Junior Dec. 15, 1924; Assoc. M. Jan. 29, 1934.) (Age 35.) Hydr. Engr., Federal Power Comm. Refers to H. K. Barrows, A. P. Campbell, A. S. Crane N. C. Grover, F. Kurtz, R. B. McWhorter.

MCGREW, EDWARD JOSEPHUS, JR., Assoc. M., New York City. (Elected Junior July 11, 1927; Assoc. M. March 27, 1933.) (Age 35.) Deputy Commr., Dept. of Plant and Structures, City of New York. Refers to W. D. Binger, S. Hardesty, C. Haydock, J. A. Knighton, E. L. Macdonald, L. S. Moisseiff, E. R. Needles, C. S. Proctor, G. S. Reeves, H. D. Robinson, B. B. Somervell, D. B. Steinman, J. A. L. Waddell.

MEEHAN, ANDREW JOSEPH ALOYSIUS, Assoc. M., Sacramento, Calif. (Elected Nov. 10, 1930.) (Age 42.) Senior Bridge Engr., State Dept. of Public Works, Div. of Highways. Refers to M. C. Collins, H. H. Gilbert, F. W. Panhorst, N. C. Raab, T. E. Stanton, Jr., D. R. Warren, G. D. Whittle.

OHR, MILO FREDERICK, Assoc. M., Detroit, Mich. (Elected Junior April 23, 1928; Assoc. M. Feb. 24, 1931.) (Age 38.) State Engr. Inspector, State of Michigan. Refers to L. E. Ayres, G. H. Fenkell, M. R. Fisher, W. C. Hirn, H. E. Riggs.

OLIVER, WILLIAM ALBERT, Assoc. M., Urbana, Ill. (Elected Junior March 16, 1925; Assoc. M. March 11, 1929.) Asst. Prof. of Civ. Eng., Univ. of Illinois. Refers to H. E. Babbitt, J. J. Doland, M. L. Enger, W. C. Huntington, G. W. Pickels, T. C. Shedd, J. Vawter, W. M. Wilson.

REYNOLDS, JOHN FRANKLIN, Assoc. M., Jacksonville, Fla. (Elected July 6, 1920.) (Age 32.) Cons. Engr. Refers to R. M. Angas, C. C. Coykendall, G. B. Hills, F. H. Mann, A. Marston, R. E. Spaulding, F. R. White.

ROSENBERG, SAMUEL, Assoc. M., Yonkers, N.Y. (Elected March 14, 1927.) (Age 46.) Res. Engr., New York State Dept. of Public Works. Refers to E. Anderberg, J. Barnett, J. Downer, C. A. Garfield, A. G. Hayden, R. M. Hodges, L. G. Holleran.

SOULE, JOHN EDWARD, Assoc. M., Ft. Barrancas, Fla. (Elected Junior Oct. 21, 1924; Assoc. M. June 27, 1932.) (Age 36.) Capt., Engr.-Res., U. S. Army; Dist. Quartermaster, Dist. "G", CCC. Refers to E. S. Bres, G. S. Burrell, J. H. Johnston, J. W. Leroux, L. E. Lyon, W. N. Woodbury.

WESSMAN, HAROLD EVERETT, Assoc. M., New York City. (Elected Junior March 14, 1927; Assoc. M. July 16, 1928.) (Age 37.) Prof. of Structural Eng., New York Univ. Refers to R. A. Black, H. Cross, S. Hardesty, W. C. Huntington, J. A. L. Waddell, C. C. Williams, W. M. Wilson.

FROM THE GRADE OF JUNIOR

BURLAND, CARLYLE GRAY, Jun., Leominster, Mass. (Elected Feb. 19, 1934.) (Age 32.) Res. Engr., Massachusetts Department of Public Works. Refers to A. W. Dean, R. K. Hale, G. E. Harkness, J. A. Johnston, A. E. Kleinert, G. A. Montague.

CARNAHAN, CHARLES TRUNNELL, Jun., Miami, Fla. (Elected Nov. 14, 1927.) (Age 32.) Associate Public Health Engr., U. S. Public Health Service. Refers to L. M. Fisher, E. Friedman, H. N. Old, L. B. Reynolds, H. W. Streeter.